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**Engineering**
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Submission:

# Specifications

## Final Submission

Project:

**NIH Building 4 Replace AHU 3, 4, and 4A**

National Institutes of Health
**Building 4**
**9000 Rockville Pike**
**BETHESDA, MD 20892**

NIH Work Request #: C112354

Presented to:

National Institute of Allergy and Infectious Diseases

Date:
May 13, 2026






**Healthcare** **Science & Technology** **Education** **Commercial**

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# SECTION 011000 - SUMMARY

## PART 1 - GENERAL

### 1.1 PROJECT IDENTIFICATION

A. Project Name and Location: National Institutes of Health (NIH), Building 4 Replace AHUs 3, 4, and 4A.

1. Construction Work Request #: C112354

2. Project Name: National Institutes of Health (NIH) Building 4 NIDDK B1-38 Lab Renovation and B1-38A Office.

3. Project Location: Building 5, Bethesda, MD 20892

B. Design Professional: The term Design Professional refers to the project designer. The Design Professional's status relative to the construction will be delineated in writing by the Contracting Officer prior to the pre-construction conference. The project was designed by:

1. Engineering:
**Global Engineering Solutions**
6700A Rockledge Drive, Suite 301
Bethesda, Maryland 20817
Contact: Anil Giri 301.216.2871

C. All correspondence from the Contractor to the Design Professional will be through the Project Officer.

D. Engineer: The term Engineer refers to the various project engineering systems designers, unless noted otherwise on drawings, all working as sub-consultants to the Design Professional. The Engineers' status relative to the construction will be delineated in writing by the Contracting Officer prior to the pre-construction conference. The project was designed by the companies indicated on the drawings.

1. All correspondence from the Contractor to the Engineer will be through the Project Design Professional via the Project Officer.

E. Project Officer: The Project Officer has been assigned for this Project to serve as the representative of the Owner and to provide assistance in administering the Contract for Construction between Government and Contractor. The Project Officer is:

1. Kanika Sharma
National Institutes of Health
OD/OM/ORFDO/ Division of Design and Construction Management / CDCB
13 South Drive
Building 13, Room 2S75

9000 Rockville Pike, Bethesda, MD 20892-5759
Telephone: 301.456.4935
Email Address: kanika.sharma@.nih.gov

1.2 WORK UNDER OTHER CONTRACTS

A. Construction Manager: A Construction Manager may manage the project for NIH. If so, the Construction Manager's status relative to the construction and identity will be delineated in writing by the Contracting Officer prior to the pre-construction conference. The Construction Manager is also referred to in some cases as the Construction Quality Manager or CQM.

B. The Contractor shall cooperate with other contractors performing related work, including providing labor, materials and other costs necessary to satisfactorily coordinate the Contract work with work performed under other contracts.

C. Preceding Work: Separate contract work may be awarded by NIH for performance of certain construction operations that are expected to be substantially complete before the Work of this Contract begins. Follow-on activities under this Contract shall be satisfactorily conducted to protect and, if indicated on the drawings, to complete the related preceding separate Contract work.

D. Concurrent Work: Separate contract work may be awarded by NIH for performance of certain construction operations that will be conducted simultaneously with the work of this contract. Interface work under this contract shall be satisfactorily conducted in compliance with the schedule requirements of the related concurrent separate contract work.

1.3 SCHEDULE OF NIH-FURNISHED PROPERTY

A. If shown on the Project drawings as Government Furnished, Contractor Installed (GFCI), the project includes the following NIH furnished property to be installed by the Contractor: biological safety cabinets, ice machines, and other miscellaneous equipment.

1. The Contractor shall notify the Project Officer in writing at least 14 calendar days in advance of the date on which the materials and equipment are required. Pick up the materials and equipment no later than 3 calendar days after the indicated required date.
2. The Contractor shall verify quantities of NIH-furnished property upon delivery and shall submit an acknowledging receipt thereof in writing to the Project Officer. Property found damaged or quantity short shall be reported to the Project Officer in writing within 24 hours.
3. The Contractor shall accept delivery at the time and location specified when delivery is made. The Contractor shall provide all handling and transportation necessary from the receiving location to the point of incorporation into the work.
4. If the materials and equipment are not picked up by the date as scheduled, the Contractor will be charged for storage at the rate of $100.00 per 45 Kg per month or fraction thereof.
5. The materials and equipment are located within 10 miles of the job site. The contractor shall provide all personnel required and means of safe transportation from the storage area to the job site.

B. The Contractor shall be responsible for disconnecting, loading, transporting, unloading, uncrating, assembly, installation, connection, and testing new materials and equipment. Schedule a joint inspection with the Project Officer to inspect the materials and equipment to determine their existing condition. Uncrate the equipment in the presence of the Project Officer and inspect for possible damaged or missing parts. The Contractor shall be responsible for all damage sustained by the materials and equipment after this inspection.

## 1.4 MISCELLANEOUS PROVISIONS

A. Work in the extension of existing conditions shall correspond in all respects with the existing conditions to which it connects, or to similar existing conditions, in materials, workmanship and finish.

B. Alterations to Existing Conditions: Existing conditions shall be cut, drilled, removed, temporarily removed, or removed and replaced, as necessary for performance of work under the contract.

1. Replacements of existing conditions that are removed shall match similar existing conditions.
2. Unless otherwise indicated, existing structural members shall not be cut or altered without authorization by the Project Officer.
3. Conditions remaining in place, which are damaged or defaced during the work, shall be restored to the condition existing at time of award of contract.
4. Discolored or unfinished surfaces exposed by removal of existing conditions, that are indicated to be final exposed surfaces, shall be refinished or replaced as necessary to produce uniform and harmonious contiguous surfaces.

C. Existing structures will remain in place unless otherwise indicated in project drawings.

D. Existing utility services shall be disconnected and removed to the extent indicated.

E. Removed items indicated to remain the property of NIH or the government and shall be stored on site where directed by the Project Officer.

## 1.5 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the 33-division format and CSI/CSC's "Master Format" numbering system.

B. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the specifications are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the specifications to determine numbers and names of sections included in the Contract Documents.

C. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

    b. The words "shall," "shall be," or "shall comply with" are stringently interpreted as "must," "must be," or "must comply with".

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 011000

# SECTION 011400 - WORK RESTRICTIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

### 1.2 SUMMARY

A. This Section documents conditions and procedures on the NIH campus that may impact the performance of work by the contractor including the following:

1. Contractor use of premises
2. NIH occupancy of adjacent premises
3. NIH occupancy prior to substantial completion
4. Working hours
5. Use of existing elevators

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to work restriction documentation including but not limited to the following Division 01 specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |

01 78 10 Project Record Documents
01 78 23 Operation and Maintenance Documentation
01 82 00 Demonstration and Training"

1.3 CONTRACTOR USE OF PREMISES

A. The Project Officer will conduct a pre-construction survey with the Contractor to review and document the existing conditions surrounding the project premises prior to the beginning of any construction activity.

B. The Contractor shall limit use of the site and premises to the work in areas indicated in the contract documents, to allow for NIH occupancy and public use.

C. Permission to interrupt any building services and/or utility services shall be requested in writing a minimum of fifteen (15) working days prior to the desired date of interruption. NIH reserves the right to refuse any request and to schedule such interruption on a later or earlier date and time which is mutually agreeable to NIH and the Contractor.

D. Temporary closing of streets, sidewalks, and/or parking areas must be coordinated with the Project Officer. The Contractor shall submit a "Request for Temporary Use of NIH Paved Area" to the Project Officer at least fifteen (15) calendar days prior to closing of any facility. Closing or restricting traffic on NIH paved areas will not be permitted except in emergencies without the approved form. Approvals shall be obtained from the following offices prior to any closure:

1. Project Officer
2. NIH Fire Department
3. NIH Police
4. NIH Parking and Traffic Control Specialist

E. The Contractor, his employees and all subcontractors shall become familiar with and comply with all NIH regulations, including fire, traffic, safety, and security regulations.

F. All personnel employed by the Contractor or subcontractors and working on the NIH campus shall keep within the limits of the work and avenues of ingress and egress. Entry to any restricted area is strictly forbidden unless they are required to do so and are cleared for such entry in writing by the Project Officer.

G. The Contractor's equipment shall be conspicuously marked for identification purposes.

H. Confine operations at the site to areas indicated. Do not disturb portions of the site beyond the areas in which work is indicated.

I. Keep driveways and entrances serving the premises clear and available at all times to NIH employees and visitors. Do not use these areas for parking or storage of materials.

J. Lock automotive type vehicles, such as trucks or other mechanized or motorized construction equipment, when parked and unattended so as to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place.

K. Schedule deliveries to minimize space and time requirements for storage of material and equipment on site.

L. Maintain existing building in a safe and weather tight condition throughout the construction period. Provide temporary heating and cooling as required to keep indoor temperatures between 65 degrees F and 80 degrees F. A heating and cooling plan shall be submitted to the Project Officer within 14 calendar days of the Notice to Proceed for approval.

M. Repair damage caused by construction operations. Take precautions to protect the building, its occupants and the public during the construction period.

N. Keep public areas, such as hallways, stairs, lobbies and toilet rooms, free from accumulation of waste material, rubbish, construction debris, and construction materials and remove such daily.

O. For all work in Building 10/ACRF, all demolition and construction debris shall be taken to the construction dumpster at the B2 level East loading dock only unless otherwise directed by NIH. Such work shall be coordinated with NIH before commencement.

P. The Contractor will not be allowed any storage area, other than within the limits of construction. Coordinate the storage of materials to maintain safe passage and emergency egress through the site at all times. If additional storage is necessary, obtain and pay for such storage off site. Payment for stored materials will not be permitted.

Q. For all work within Building 10, no exterior window can be opened without the prior written consent of the Project Officer. The building complex is under negative pressure and incoming air will affect the operation of the HVAC system.

R. Use of the existing loading dock facilities will be shared with NIH activities on a first-come-first-served, wait-your-turn basis, unless otherwise directed.

1. For all work in Building 10/ACRF, access to the building for material delivery shall be limited to the use of the B2 level East loading dock, unless otherwise directed. Under no circumstances is the Contractor authorized to use the B1 level south loading dock. Coordinate such work NIH before commencement.

S. Existing materials and equipment that are removed as part of the construction operations, and that are not reused or designated to be salvaged as NIH or other's property, shall be removed from the site. Storage or sale of excess salvageable materials and equipment is not permitted on site.

T. Pollution producing equipment shall not be located near air intakes where airborne smoke or fumes could be drawn into the building.

U. For parking restrictions in effect under this contract see Section H of the Contract.

V. Electric arc welding equipment shall not be connected to the building power supply system.

W. The contractor will be allowed to utilize existing toilet facilities.

X. Existing Stair Usage: Use of existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to the NIH. Prior to Substantial Completion, restore stairs

to condition existing before initial use and maintain in their original condition until Substantial Completion.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work.

1.4 NIH OCCUPANCY OF ADJACENT PREMISES

A. NIH will occupy the existing building areas immediately adjacent to, and below the construction site during the entire period of construction, unless otherwise specified.

1. Cooperate with NIH representatives during construction operations to minimize conflicts and facilitate NIH usage. Perform the work in a manner that does not interfere with NIH operations. Delays may be incurred. If the Project Officer determines that the safety and health of building occupants is in jeopardy, the Contractor must modify his construction plan and procedures to avoid the potential hazard before continuing with construction.
2. Uninterrupted operation shall be maintained in all areas.

1.5 Unscheduled Operations

A. NIH may restrict work in or around some hospital, laboratory, or animal holding areas on an unscheduled basis. NIH will provide not less than 24 hour notification each time work restrictions due to unscheduled NIH operations are invoked, except for emergencies.

1.6 WORKING HOURS

A. Contractor shall coordinate all working hours including after hours/weekends and holidays with NIH.

B. Contractor shall plan and perform work that involves excessive noise, dust, fumes, or other major disruption to the occupants nearby (including above, below, and adjacent to the site or travel path to the site) to occur after occupied hours. Coordinate such activity with the Project Officer in writing not less than fifteen (15) calendar days in advance of proposed work.

C. Requests for deviations from General Working Hours, including work on holidays, shall be submitted in writing to the Project Officer not less than fifteen (15) calendar days in advance of the proposed work period. Once approved, the schedule must be delivered to the NIH Police prior to the start of work.

D. NIH Unoccupied Hours will be defined, if applicable. The Contractor shall submit a proposed schedule and gain the Project Officer's approval at least 72 hours before proceeding with any work during NIH Unoccupied Hours.

E. Temporary Suspension of Work: The Contractor shall suspend work during the period as identified by the NIH contract manager. Contractor shall not be entitled to an adjustment of the Contract price or time of performance as a result of this suspension of work.

1.7 USE OF EXISTING ELEVATORS

A. For work in existing NIH buildings, the Contractor will be permitted to use an existing freight elevator for freight service and transportation of construction personnel during the construction period.

B. Elevators will be used by both contractor and NIH and must be available to NIH at all times. Coordinate usage with the Project Officer. Use of any elevator is on a first come first use basis. Delays may be incurred.

C. Protection of existing elevators: Provide protective pads for the cab and other appropriate protective measures for the car and entrance doors and frames. The Contractor shall not load the elevator to more than 75% of the rated capacity or the capacity indicated by the elevator operator, whichever is less. The Contractor is responsible for making repairs to any damage to the elevators during his use. If the Contractor fails to promptly repair any damage to the elevator or if the elevator is required to discontinue service, NIH may make any necessary repairs it deems required and deduct all associated costs directly from this construction contract. At the end of construction, restore the elevator to its original condition; replace worn cables, guide shoes and similar items of limited life.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 011400

# SECTION 012300 - ALTERNATES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

### 1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

### 1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. - N/A

END OF SECTION 012300

# SECTION 012600 - OPTIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for options.

### 1.3 DEFINITIONS

A. Option: An amount proposed by the Contractor and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added by NIH to the project Work within a specific time period after award of the Contract.

1. The amount for an option shall be the net total addition or credit to the Contract price to incorporate the option work into the project work.

### 1.4 PROCEDURES

A. Selection: An option must be accepted by NIH within the time specified in the Contract in order to be included in the project work.

B. Coordination: Modify or adjust affected adjacent work as necessary to completely and fully integrate the accepted option work into the Project.

1. Include as part of each option, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of option.

C. Notification: If an option is accepted by NIH, the Contractor shall immediately notify each subcontractor and party involved, in writing, of the acceptance of the option. Include a complete description of negotiated modifications to options.

D. Execute accepted options under the same conditions as other work of the Contract.

E. Schedule: A Schedule of Options is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate. Specification sections referenced may not be inclusive and other specification sections in the contract may also apply.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF OPTIONS

A. Option No. 1: Provide all work required to <**Insert option description**>, as indicated on the Drawings, labeled Option No. 1, and as specified. Option No. 1 must be accepted by NIH within the timeframe specified in the Contract, or not at all.

END OF SECTION 012600

# SECTION 012900 - PAYMENT PROCEDURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of

B. Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

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

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
2. Division 01 Section "Submittal Procedures" for administrative requirements governing the preparation and submittal of the submittal schedule.

### 1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule. Cost-loaded Critical Path Method Schedule shall be used to satisfy requirements for the schedule of values.

1. Correlate line items in the schedule of values with other required administrative forms and schedules, including the following:

    a. Application for Payment forms with continuation sheets.
    b. Submittal schedule.
    c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Project Officer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub-schedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
4. Sub-schedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide sub-schedules showing values correlated with each element.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

    a. Project name and location.
    b. Name of Project Officer
    c. Governments project number
    d. Name of Design Professional.
    e. Design Professional's project number.
    f. Contractor's name and address.
    g. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

    a. Related Specification Section or Division.
    b. Description of the Work.
    c. Name of subcontractor.
    d. Name of manufacturer or fabricator.
    e. Name of supplier.
    f. Change Orders (numbers) that affect value.
    g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

        1) Labor.
        2) Materials.
        3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of Contract Sum.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

9. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

## 1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Design Professional and paid for by Project Officer.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: Progress payments shall be submitted to Project Officer by the fifteenth day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

1. Submit draft copy of Application for Payment seven days prior to due date for review by Project Officer.

C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Project Officer will return incomplete applications without action.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under Project Officer-requested project acceleration.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Project Officer, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Materials previously stored and included in previous Applications for Payment.
b. Work completed for this Application utilizing previously stored materials.
c. Additional materials stored with this Application.

d. Total materials remaining stored, including materials with this Application.

F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Project Officer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Project Officer reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Project Officer.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values including proposed earned value curve for project.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Schedule of unit prices.
6. Submittal schedule (preliminary if not final).
7. List of Contractor's staff assignments.
8. List of Contractor's principal consultants.
9. Initial progress report.
10. Report of preconstruction conference.
11. Certificates of insurance and insurance policies.
12. Performance and payment bonds.
13. Data needed to acquire Owner's insurance.

I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Project Officer took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

# SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS.

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

### 1.2 SUMMARY

A. This Section includes administrative provisions for managing and coordinating construction operations including, but not limited to, the following:

1. General project coordination.
2. Contractor Security Plan
3. Document Control
4. Communication
5. Release of Information
6. Utility service interruptions.
7. As-Built Building Information Model (AutoCAD).
8. Administrative and supervisory personnel.
9. Conferences and meetings.
10. Cleaning and protection.

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to project management and coordination. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |

| | |
|---|---|
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

1.3 GENERAL PROJECT COORDINATION

A. Contractor Security Plan: The Contractor Security Plan shall include provisions to address an approach to overall security that is consistent with the goals contained in existing NIH Security Policies, Guidelines and Regulations. Security goals are as follows:
   1. Screen A/E contractor workforce consistent with NIH policies and procedures.
   2. Safeguard NIH employees and assets from events or persons who could cause harm.
   3. Limit Project information distribution and ensure compliance with the National Institutes of Health Confidentiality Non-Disclosure Certification to authorized persons and entities to the greatest extent that is practical.

B. Document Control
   1. The Contractor shall assume responsibility for and maintain records of distribution of all drawings, specifications and other project information. Such information shall be distributed only to those specifically with a need for them to accomplish the Work.
   2. Certain documents may be marked as “Sensitive Unclassified - For Official Use Only” or “Law Enforcement Sensitive”, hereinafter called “sensitive” information which may include drawings, sketches, digital photographs, exposed negatives, video, written descriptions of work requirements, and similar information. Return such information promptly to Project Officer upon request, including any copies.
      a. Store all Project Information in file cabinets locked during non-business hours. Store “Sensitive” documents in separate containers with access restricted to those with a specific need for use of the information.
      b. Reproduction of documents shall be kept at the minimum needed to accomplish the Work, and all copies shall be numbered and recipients recorded. “Sensitive” documents shall be returned to the NIH Project Officer when no longer needed, and the NIH will arrange for their proper disposal.
      c. Limit dissemination of sensitive information on need-to-know basis.
      d. Any proposed deviations from these requirements must be submitted to the Project Officer for review. Approval may or may not be granted.
      e. Do not allow removal/transmission of such information from Project Site without prior written approval by Project Officer.
      f. “Sensitive” documents shall be transmitted using U.S. Postal Service or any commercial services that permit delivery only after receiving signature.
      g. All paper waste and electronic media such as diskettes and CDs of “Sensitive” documents shall be shredded or otherwise destroyed in a manner acceptable to the NIH.
   3. Notification and Reporting: Notify both the Project Officer and DPSM immediately when known or suspected loss/compromise of “sensitive” information or other documents, notes, drawings, sketches, reports, photographs, exposed films, or similar information has

occurred which may affect the security interests of the NIH. Extend this requirement to employees and other personnel working on behalf of Contractor, and expand the responsibility to include prompt reporting of security issues, including observed efforts by unauthorized persons to gain access to sensitive information.

4. The Contractor and each sub-contractor or other entity involved in the Project shall submit an electronic security memorandum describing the approach to meeting the above goals and maintaining confidentiality of Project files The memorandum shall describe security within the Project, including any intrusion prevention and detection methodology.
    a. The Contractor shall not proceed without NIH's written approval of the memorandum.
    b. Any requests for exceptions from these requirements shall be submitted in writing to the Project Officer for review. No entity or person shall proceed with such exception without written approval by the NIH.
5. Electronic Document Security
    a. All Electronic files shall be stored in specified location following NIH standards and procedures using an Engineering Document Management Software (EDMS).
    b. Each Project shall have a registry file, listing the project team with their contact information, drawing list, and Revision index stored in the same location of the other project documents.
    c. Security, access and maintenance of all project engineering drawings and related documents, both scanned and electronic, shall be performed and tracked through the EDMS system.
    d. All documents shall be distributed among team members, including A/E, DM, CM, and their sub-contractors with approval and knowledge of the NIH Project Officer.
    e. Three principles shall always be followed in providing information:
        1) Only give the information to those that have a need to know.
        2) Keep records of who received the information.
        3) Safeguard the information during use.

C. Communication

1. Use of telephone or facsimile for communications will not be restricted except that these means shall not be used for "Sensitive" information.
2. "Sensitive" information, including drawings and other documents. May be attached to electronic mail provided a commercially available encryption software compatible with Microsoft Outlook approved in advance for use by The NIH.
3. If computer area networks are used for performing administrative or technical work, electronic partitions must be installed to limit access by unauthorized personnel to electronic files. Electronic files shall be organized to allow complete purging of files at the conclusion of the Work.

D. Release of Information: No information pertaining to Work the shall be released for publication, including, but not limited to, press releases, internet posting, advertisement, marketing or solicitation without prior written approval of the NIH.

E. Coordination of Trades: Coordinate construction operations included in the various sections of the Specifications to provide an efficient and orderly installation of each part of the Work. Coordinate construction operations included under different sections of the Specifications that depend on each other for proper installation, connection or operation.

1. Schedule construction operations in the sequence required to obtain the best results where the installation of one part of the work depends on installation of other components before or after that part.

2. Coordinate installation of different components to provide maximum accessibility for required maintenance, service, removal/installation of component parts, testing and repair.

3. Accommodate items scheduled for later installation.

4. Provide for coordinated incorporation of Contractor's accepted Value Engineering proposals and Change Orders.

5. Locate pipes, conduits, ducts, equipment, and their related supports so that they do not interfere with the intended use of lifting devices for adjacent equipment and components.

F. Notification: Where required by this section and others, prepare and distribute memoranda to each party performing work at the project site, outlining special procedures required for coordination, including required notices, reports, attendance at meetings and meeting minutes as part of the memoranda.

G. Administrative Procedures: Coordinate scheduling and timing of administrative procedures with other construction activities to avoid conflicts and promote orderly progress of the work. Administrative procedures include but are not limited to the following:

1. Preparation of schedules and management plans.
2. Installation and removal of temporary facilities and controls.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Pre-installation conferences
6. Project commissioning and closeout activities.

H. Utility Service Interruption Plan

1. Contractor shall submit a Utility Service Interruption Plan for the project. Plan shall include proposed dates and times of each scheduled interruption based on the construction schedule, with estimated period of outage, list of existing equipment that will be affected by the interruption, proposed sequence of equipment shut-down and start-up, and responsible personnel. The plan should incorporate the following guidance:

    a. Frequency and duration of interruption should be minimized.
    b. Interruptions should be scheduled during times when the facility is unoccupied.
    c. Requirements contained in the NIH ORF Manual “Policy and Procedure Utility Shutdown”, latest edition, available on the NIH Website.

2. Plan must be approved in writing by the Contracting Officer and the Project Officer. If not approved, consult with the Project Officer, and revise and resubmit the plan until approved.
3. Requests for Utility Outages and Connections shall be made in writing to the Project Officer at least 15 calendar days in advance of the date and time required. Each request

shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

4. Utility outages and connections required during the performance of the work that affect existing systems and are deemed by the Project Officer to jeopardize normal NIH operations shall be made during other than normal duty hours.
5. Coordination and notification to NIH tenants and activities will be accomplished by the Project Officer following notification by the contractor.
6. Prior to each interruption, the Contractor will confirm with the Project Officer that any necessary NIH personnel are prepared to execute the shut-down and start-up of affected existing equipment.

## 1.4 SUSTAINABLE CONSTRUCTION AND CONSERVATION PROGRAMS

A. Consider conservation of energy, water and materials, and otherwise apply sustainable construction practices in the conduct of construction operation. Salvage materials and equipment involved in the performance of, but not incorporated into, the work.

B. Hazardous Materials Waste Management Plan

1. Contractor shall establish and submit for approval a Hazardous Materials Waste Management Plan within 14 calendar days of the Notice to Proceed or at least 14 calendar days prior to introducing hazardous materials on the site.
2. The Hazardous Materials Waste Management Plan shall be included (in draft form if approved copy is not available) with the submission of the Contractor's Safety and Health Program.
3. Requirements for the Hazardous Material Waste Management Plan are located in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material."

C. Heating and Cooling Plan

1. Contractor shall submit a Heating and Cooling Plan for the project when the work will impact the conditioned spaces of existing NIH facilities. Plan shall include written description of how the contractor intends to maintain the interior temperature between 65 degrees F and 80 degrees F or at other environmental conditions specified in the project documents. Include in the plan the heating and cooling of temporary facilities which enclose existing NIH spaces. Where plan requires use of permanent equipment to provide this conditioning, refer to 015000 for submission of the Temporary Operation and Conditioning Plan.

## 1.5 SUBMITTALS

A. Contractor Security Plan: Develop and submit a Contractor Security Plan to the Contracting Officer for Approval within 14 calendar days after Notice to Proceed.

B. Utility Service Interruption Plans

1. Develop and submit a Utility Service Interruption Plan to the Contracting Officer for approval within 14 calendar days after the Notice to Proceed and at least 15 calendar days

in advance of the first requested interruption to coincide with the request for utility outage.
2. Update the plan and re-submit when conditions change at least 15 calendar days in advance of the first requested change to a utility interruption.
3. Include a copy as an appendix to the Quality Control Plan.

C. Hazardous Waste/Waste Management Plan

1. Develop and submit to the Contracting Officer for approval within 14 calendar days after Notice to Proceed a Hazardous Waste/Waste Management Plan that conforms to the requirements contained in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials."
2. Update the plan and re-submit for information when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

D. Heating and Cooling Plan

1. Develop and submit to the Contracting Officer for approval within 14 calendar days after Notice to Proceed a Heating and Cooling Plan for occupied NIH spaces effected by the project work.
2. Update the plan and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

E. Integrated Pest Management Service Plan

1. Develop and submit to the Contracting Officer for approval within 14 calendar days after Notice to Proceed a Integrated Pest Management Service Plan conforming to the requirements identified in Division 01 Section "Temporary Facilities and Controls."
2. Update the plan and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

F. Severe Storm Plan

1. Develop and submit to the Contracting Officer for approval within 14 calendar days after Notice to Proceed a Severe Storm Plan conforming to the requirements identified in Division 01 Section "Safety and Health."
2. Update the plan and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

G. Demolition Plan

1. Develop and submit to the Contracting Officer for review within 14 calendar days after Notice to Proceed and at least 14 calendar days prior to the planned commencement of demolition activities a Demolition Plan conforming to the requirements identified in Division 01 Section "Selective Demolition" or other demolition related sections.
2. Update program and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

H. Photographic Documentation Plan

1. Develop and submit to the Contracting Officer for review within 14 calendar days after Notice to Proceed a Photographic Documentation Plan conforming to the requirements identified in Division 01 Section "Photographic Documentation."
2. Update program and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

I. Quality Control Plan

1. Develop and submit to the Contracting Officer for approval within 30 calendar days after Notice to Proceed a Quality Control Plan conforming to the requirements identified in Division 01 Section "Construction Quality Control."
2. Update program and re-submit for approval when conditions change.

J. Safety and Health Program

1. Develop and submit to the Contracting Officer for review within 14 calendar days after Notice to Proceed the Contractor's Safety and Health Program as required by Division 01 Section "Safety and Health."
2. Update program and re-submit for approval when conditions change.

K. Cutting and Patching Plan

1. Develop and submit to the Contracting Officer for approval a cutting and patching plan for approval at least 21 calendar days in advance of the time cutting and patching will initially be performed as required by Division 01 Section "Cutting and Patching."
2. Update program and re-submit for approval when conditions change.
3. Include a copy as an appendix to the Quality Control Plan.

L. Project Closeout and Work Plan

1. Develop and submit to the Contracting Officer for approval a project closeout and work plan for approval at least 15 calendar days prior to the Substantial Completion Inspection as required by Division 01 Section "Closeout Procedures."
2. Update program and re-submit for approval when conditions change.
3. Coordinate contents of this plan with Division 01 Section "Construction Quality Control" and the contents of the Quality Control Plan.

M. Staff Names: Within 14 calendar days of the start of site operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.
2. Provide updated lists when individuals assigned to positions change or positions are added to the contractor's staff team.

N. Meeting minutes: The contractor shall provide meeting minutes from the following meeting as required by this section. Additional meeting minutes requirements may be located in other sections.

1. Preconstruction Conference.
2. Preinstallation Conferences.
3. Progress meetings.
4. Coordination Meetings
5. Coordination BIM Meetings
6. Health and Safety Meetings

1.6 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. In addition to the Project Superintendent, the Contractor shall provide other administrative and supervisory personnel as required for proper performance of the work.

B. Project Coordinator: Provide a full-time project coordinator, experienced in the administration and supervision of building construction, including mechanical and electrical work. The project coordinator shall at minimum have a Bachelors degree from an accredited university or college in the field of construction management, engineering, architectural engineering or architecture, and shall be authorized to act as the coordinator of construction activities, including but not limited to the following:

1. Scheduling and sequencing of work.
2. Sharing access to work spaces.
3. Installations.
4. Protection of work.
5. Cutting and patching.
6. Selections for compatibility.
7. Preparation of coordination of drawings.
8. Inspection and tests.
9. Temporary services and facilities.
10. Conduct Project Coordination Meetings

C. Mechanical and Electrical Coordinator: Provide a full-time mechanical and electrical coordinator, with a Bachelor of Science degree in mechanical, electrical or architectural engineering from an accredited college or university, a minimum of five years experience in the coordination of mechanical and electrical construction of the types and complexity required for the project, and experienced in coordination of mechanical and electrical construction with other operations. The mechanical and electrical coordinator shall be authorized to act as the coordinator for mechanical and electrical activities, including but not limited to the following:

1. Scheduling and sequencing of mechanical and electrical activities.
2. Sharing access to mechanical and electrical work spaces.
3. Integration of mechanical and electrical work into limited spaces available for mechanical and electrical installations.
4. Protection of mechanical and electrical work.
5. Cutting and patching for mechanical and electrical work.
6. Tolerances for mechanical and electrical work.
7. Preparation of mechanical and electrical coordination drawings.
8. Application of BIM-based coordination techniques to identify and resolve spatial conflicts
9. Mechanical and electrical inspections and tests.
10. Utilization of mechanical and electrical temporary services and facilities.

11. Commissioning

D. Safety and Health Officer: Provide a full time safety and health officer whose duties shall consist of developing and implementing safety and health programs specified in Division 01 Section "Safety and Health."

1. Other Duties: Safety and Health Officer shall not have other duties.
2. Additional Requirements: See Division 01 Section “Safety and Health” for additional requirements and information regarding the Safety and Health Officer.
3. Additional Safety and Health Officers:

a. For each additional 75 employees (including Subcontractor employees) above 40 on any shift, provide one additional full time Safety and Health Officer.

1) Upon review by the Project Officer, requirement for additional Safety and Health Officer(s) may be wholly or partially waived at Project Officer’s sole discretion.

E. Environmental Safety Officer/Industrial Hygienist: Provide the services of an Industrial Hygienist with duties as indicated in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material."

F. Integrated Pest Management Quality Control Supervisor: Provide an Integrated Pest Management Quality Control Supervisor with duties as indicated in Division 01 Section "Temporary Facilities and Controls."

## 1.7 CONFERENCES AND MEETINGS

A. Pre-construction Conference:

1. The Contractor shall attend a pre-construction conference scheduled by the Project Officer at a time and place convenient to both parties. Work shall not commence prior to the conference. Conference shall review responsibilities and personnel assignments.
2. Attendees: Participants at the conference shall be familiar with the project, shall be authorized to conclude matters relating to the Work, and at a minimum include representatives of the following parties or their designated representatives:

a. Contracting Officer.
b. NIH Project Officer
c. Design Professional.
d. Major design consultants.
e. Contractor
f. Major subcontractors
g. Major Suppliers
h. NIH Police
i. NIH Division of Safety, including representatives from the Pest Management Section and the Occupational Safety and Health Branch
j. Other concerned parties.

3. Agenda: Subjects for discussion shall include items of significance that could effect progress, including but not limited to the following:

    a. Tentative construction schedule.
    b. Critical work sequencing.
    c. Designation of responsible personnel.
    d. Procedures for processing field decisions and Change Orders.
    e. Procedures for processing Applications for Payment.
    f. Distribution of Contract Documents.
    g. Submittal of Shop Drawings, Product Data, and Samples.
    h. Preparation of Record Documents.
    i. Use of the premises.
    j. Parking availability.
    k. Office, work, and storage areas.
    l. Equipment deliveries and priorities.
    m. Safety and Health procedures
    n. First Aid
    o. Security
    p. Housekeeping and progress cleaning
    q. Working hours
    r. Permits
    s. Integrated Pest Management procedures.

4. Reporting: No later than 3 calendar days after the conference, the Contractor shall distribute minutes of the conference to each party present and to other concerned parties, including the Contracting Officer.
5. This meeting may satisfy the requirement for a Pre-construction Safety Meeting in Division 01 Section "Safety and Health."

B. Pre-installation Conferences: The Contractor shall conduct a pre-installation conference at the Project Site before each construction activity that requires coordination with other construction. Pre-installation conferences may be combined with Preparatory Phase meetings described in Division 01 Section "Construction Quality Control."

1. Attendees: In addition to the Contractor's representative, the installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend. Prior to conferences, advise the Contracting Officer of scheduled conference dates.
2. Agenda: Review the progress of other construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for the following.

    a. Contract Documents
    b. Options
    c. Related Change Orders, including accepted Value Engineering proposals
    d. Purchases
    e. Deliveries
    f. Submittals
    g. Review of mockups
    h. Possible conflicts

i. Compatibility problems
j. Time schedules
k. Weather limitations
l. Manufacturer's recommendations
m. Warranty requirements
n. Compatibility of materials
o. Acceptability of substrates
p. Quality requirements
q. Temporary facilities and controls
r. Space and access limitations
s. Governing regulations
t. Safety
u. Testing and inspection requirements
v. Required performance results
w. Protection.

3. Reporting: Record significant discussions and agreements and disagreements of each conference. No later than 3 calendar days after each conference, the Contractor shall distribute minutes of the conference to each party present and to other concerned parties, including the Contracting Officer.
4. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to the performance of the work, and reconvene the conference at the earliest feasible date.

C. Pre-Demolition Conference: The Contractor shall conduct conference at project site. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.
5. Discussion of any outstanding issues from NIH review of Contractor's Demolition Plan.

D. Progress Meetings: The Project Officer shall conduct progress meetings at the Project Site at frequency stipulated by the Project Officer at the Pre-construction Meeting. Dates of meetings shall be coordinated with preparation of the payment request.

1. Attendees: In addition to the Contractor and Project Officer, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work. The Project Officer shall include the Contracting Officer and/or the project designer in these meetings as required. The contractor is responsible for requesting the Contracting Officer and/or designer attend and provide justification to the Project Officer.
2. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

3. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine the required contractor response to construction behind schedule; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.

    a. At each progress meeting, the Contractor will provide a list of construction activities completed since the previous Progress Meeting, activities in progress with percent completed, activities scheduled to start in the next 14 calendar days, and activities to start in the next thirty calendar days as derived from the accepted project schedule.
    b. At each progress meeting, the Contractor will provide a list of construction activities whose start date or anticipated completion date deviate from the approved Construction Schedule by 7 or more calendar days. For each such identified activity, the Contractor shall:

        1) Indicate whether or not the activity is on the critical path of the project.
        2) Identify action items necessary to minimize delay of the activity start or finish.
        3) Identify action items necessary to recover lost time.

    c. Schedule Updating: The Contractor shall revise the Contractor's Construction Schedule to reflect project progress after each progress meeting and include revisions approved by the Contracting Officer.

        1) Schedule updates shall retain the Approved Construction Schedule in the form of a visual baseline format.
        2) Schedule updates shall include links to Coordination BIM.

    d. The revised schedule shall be issued monthly to correspond with the submission of the Contractor's application for payment.

4. Review the present and future needs of each entity present, including but not limited to the following:

    a. Interface requirements
    b. Time
    c. Sequence of operations
    d. Status of submittals
    e. Deliveries
    f. Off-Site fabrication
    g. Access
    h. Site Utilization
    i. Temporary facilities and controls
    j. Hours of work
    k. Hazards and risks
    l. Proposed or scheduled utility service interruptions
    m. Housekeeping and progress cleaning
    n. Quality and work standards
    o. Deficiencies

p. Change Orders
q. Documentation of information for payment requests

5. Reporting: The Project Officer may stipulate minutes of Progress Minutes to be prepared by the Design Professional. If not so stipulated, no later than 3 calendar days after each meeting, the Contractor shall prepare and distribute minutes of the meeting to each party present and to other concerned parties who should have been present, including the Contracting Officer. Include a brief summary, in narrative form, of progress since the previous meeting and report. Minutes shall contain a minimum of the following:

   a. Summary of "old business" items including date item was first discussed, discussion at subsequent meetings, and description of resolution of item and resolution date. Old business items will not be removed from minutes until fully resolved.
   b. Summary of "new business" items including assignment of action items necessary for resolution.
   c. Summary of safety issues.
   d. Summary of project activity related to Contractor Requests for Information (RFIs), Architect's Supplemental Instructions (ASIs), and submittals and submittal reviews. Include:

      1) List of any items affecting or likely to affect Project cost or schedule.

6. The Contractor shall present Record Drawings at progress meetings for review by the NIH, if so requested.
7. The Progress meeting may be in conjunction with the Quality Control (QC) Meeting required per Division 01 Section "Construction Quality Control."

E. Coordination Meetings: Conduct weekly project coordination meetings as required, to verify detailed coordination procedures for the upcoming construction operations in order to avoid potential problems and misunderstandings.

1. Attendees: In addition to the Contractor and Project Officer, each subcontractor, supplier or other entity involved in coordination or planning construction activities shall be represented. All participants shall be authorized to conclude matters relating to the work.
2. Agenda: Review the plans and requirements of each entity present, including but not limited to the subjects listed for Progress Meetings.
3. Reporting: No later than 3 calendar days after each meeting, the Contractor shall distribute minutes of the meeting to each party present and to other concerned parties who should have been present, and including the Contracting Officer. Include a brief summary, in narrative form, of progress since the previous meeting and report.

## 1.8 CONSTRUCTION RISK ASSESSMENT (CRA) AND INTERIM LIFE SAFETY MEASURES (ILSM) MANAGEMENT AND COMPLIANCE REQUIREMENTS FOR PROJECTS LOCATED IN THE BUILDING 10/CRC COMPLEX (BUILDING 10, ACRF WING, AND CRC)

A. The Building 10/CRC complex is a patient care facility subject to the Joint Commission (TJC) (formerly known as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO)) requirements. NIH maintains an ILSM for the complex that affects construction

means and methods and which requires close coordination and compliance by the Contractor. Such management and compliance requirements include but are not limited to the paragraphs in this Section 1.8:

B. The Contractor shall comply with Construction Risk Measures that identify and addresses hazards that could potentially compromise patient care, treatment, and services in occupied areas of the Building 10 complex (i.e., Buildings 10, 10B (ACRF), CRC, and NMR imaging center). Hazards include air quality requirements, infection control measures, utility requirements, noise, vibration and emergency procedures.

C. Construction Risk Measures must be implemented prior to the project execution phase and be maintained through demolition, construction or renovation till the completion of the project.

D. The Contractor shall complete the Construction Risk Assessment (CRA) to identify, develop and implement control measures required for the TYPE, GROUP and CLASS of area in which work will be performed (using the Patient Risk Group Drawings) and for adjacent areas that may be affected by the work.

E. The Contractor shall complete the information included in the CRA procedure, distribute this information to the project officer and receive approval from the government prior to starting work.

F. This Construction risk assessment process shall be repeated each time when the location or character of work changes.

G. Construction risk measures include but are not limited to scheduled times and thresholds for vibration and noise; barriers to contain particulates including sticky carpet mats, smoke-tight wall boards, air pressure differentials, and filtration devices; redundant or comparable safeguards to maintain effective odor removal, air conditioning, humidification, heating, critical air quality and clinical parameters required for patient care and the safety of all occupants, and emergency procedures.

H. The TYPE, GROUP, and LOCATION of the work determines when and to what extent construction risk measures applies to the work performed by the contractor.

I. The Contractor shall comply with the ILSM established by the NIH Division of the Fire Marshal or the Clinical Center. These measures shall be implemented for all construction, renovation and alteration work and periods when the work compromises the fire protection systems such that the facility does not meet applicable provisions of the Life Safety Code®.

1. Prior to use, the project officer, with the CC safety officer and CC Office of Facility Management will assess the risks associated with the flammables, oxidizers, irritants, and other potentially hazardous chemicals proposed for use in the work area.
2. The NIH Division of the Fire Marshal, the fire safety “authority having jurisdiction” (AHJ), as well as the project officers will monitor renovation and construction areas for compliance with the ILSM.
3. The NIH AHJ shall approve all completed work for compliance with the provisions of the National Fire Codes prior to acceptance and beneficial occupancy of the space.
4. Daily Inspections:

a. The Contractor's Project Manager or Superintendent shall monitor compliance with the ILSM on a continuous basis and complete and post an ILSM compliance checklist daily.
b. Contractor shall address ILSM requirements in their daily report that shall be provided to the Project Officer.
c. Non compliance with checklist is sufficient cause for a "Stop Work Order".

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of Conditions: Prior to installations, require the installer of each component to inspect both the substrate and conditions under which work is to be performed.

1. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
2. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

B. Construction in Progress: Keep construction in progress, adjoining materials in place, and adjoining materials clean during handling and installation. Apply protective coverings where required for protection from damage or deterioration.

C. Completed Construction: Clean completed construction, and provide maintenance, as frequently as necessary to prevent damage or soiling or other deterioration through the remainder of the construction period. Adjust and lubricate operable components as necessary to assure operability without damage.

D. Limiting Exposures: Supervise construction operations to prevent exposure of any part of construction, completed or in progress, to harmful, dangerous, damaging or otherwise deleterious conditions during the construction period. Such conditions include but are not limited to the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Pollution and air contamination.
7. Water or ice.
8. Chemicals and solvents.
9. Light
10. Radiation
11. Puncture
12. Abrasion
13. Heavy Traffic

14. Soiling, staining, and corrosion
15. Bacteria
16. Rodent and insect infestation
17. Combustion
18. Electrical Current
19. High-speed operation
20. Improper lubrication
21. Unusual wear or other misuse
22. Contact between incompatible materials
23. Destructive testing
24. Misalignment
25. Excessive weathering
26. Unprotected storage
27. Improper shipping or handling
28. Theft or vandalism

END OF SECTION 013100

# SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes certain schedules and reports required for documenting the progress of construction during the performance of the work, including the following:

B. This section includes the entire spectrum of construction schedule requirements from simple hand written bar charts to complex CPM diagrams. Edit this section after determining and confirming with the Project Officer the level of schedule complexity required.

C. Select the following sub-paragraphs which apply to this project. Selection should be confirmed with the Project Officer when confirming the scope of the proposed contractor's quality control effort being required for the project. Coordinate selection with schedules included in Submittals article and Part 2 of this section.

1. Preliminary Construction Schedule
2. Contractor's Construction Schedule
3. Material and Equipment Delivery Schedule
4. Submittal Schedule
5. Contractor's Production Report
6. Material Location Reports
7. Field Condition reports
8. Special reports

D. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to construction progress documentation. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |

| | |
|---|---|
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

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

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

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

E. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either the NIH or the Contractor.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

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

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

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

1.4 SUBMITTALS

A. Preliminary Construction Schedule: Submit the Preliminary Construction Schedule to the Contracting Officer within 10 calendar days following receipt of the Notice to Proceed.

B. Contractor's Construction Schedule: Submit the Contractor's Construction Schedule to the Contracting Officer within 30 calendar days after Notice to Proceed.

C. Submittal Schedule: Prepare and submit a complete schedule of submittals within 10 calendar days after receipt of Notice to Proceed.

1. Sustainable Construction Matrix: Submit matrix of products and construction activities with sustainability requirements (specified in Section “Project Management and Coordination” concurrent with Submittal Schedule.

D. Contractor's Production Report: Reports are required for each day that work is performed and shall be attached to the Contractor Quality Control Report specified in Division 01 Section "Construction Quality Control" prepared for the same day.

E. Material Location Reports: At not more than weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at the site.

F. Field Condition Reports: When the need to take corrective action requires a departure from the Contract Documents, prepare a detailed report describing the problem and recommended changes and submit a copy to the Project Officer.

G. Special reports

1. Unusual Event Reports: When an event of an unusual and significant nature occurs at the site, prepare a detailed report. List the chain of events, persons participating, response by the Contractor's personnel, evaluation of the results or effects, and similar pertinent information. Submit a copy to the Project Officer immediately. Advise the Project Officer in advance when such events are known or anticipated.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT DELIVERY SCHEDULE.

A. Submit for Contracting Officer approval a schedule showing procurement plans for materials, plant, and equipment. Submit in the format and content as directed by the Contracting Officer and include as a minimum the following information:

1. Description
2. Date of purchase order
3. Promised shipping date
4. Name of manufacturer or supplier
5. Date delivery is expected
6. Date the material or equipment is required according to the current construction schedule

B. Update the equipment delivery schedule at monthly intervals indicating material deliveries and purchases. Reflect any changes occurring since the last update. Submit copies of the purchase orders and confirmation of the delivery dates as directed.

1. Revisions to the approved schedule which will change completion dates require Contracting Officer approval.

2.2 PRELIMINARY CONSTRUCTION SCHEDULE:

A. Prepare and submit for Contracting Officer approval a preliminary time scaled arrow diagram for the project comprised of an outline of activities for the first 30 calendar days of construction. Include each significant construction activity. Coordinate each activity in the network with other activities. Schedule each activity in proper sequence and show the critical path graphically. Include the following minimum information for each activity:

1. Beginning event number
2. Description
3. Duration estimate
4. Scheduled start or days after commencement of the contract
5. Scheduled finish date or days after commencement of the contract.

B. Provide a separate fragnet for each Definable Feature of Work included in the Draft Contractor QC Plan required by Division 01 Section "Construction Quality Control."

C. Schedule shall be time scaled in not more than weekly increments with dates of the first day of each week (Sunday) indicated.

D. Completion of the work shall be in advance of the date for completion of the contract.

E. Provide a skeleton diagram for the work beyond the preliminary time scaled arrow diagram.

F. Cash Requirements Prediction: With the submission of the Preliminary Construction Schedule, include a preliminary monthly cash requirement prediction based on the scheduled progress of the activities.

G. Distribution: Submit 3 copies of the preliminary construction schedule to the Contracting Officer.

H. Within 10 calendar days after receipt of the preliminary construction schedule, the Contracting Officer will meet with the Contractor for a joint review, correction and adjustment of the preliminary schedule.

I. Within 5 calendar days after the joint review, the Contractor shall revise the preliminary construction schedule in accordance with agreements at the joint review, and submit 3 copies of the revised Preliminary Construction Schedule to the Contracting Officer. The resubmission will be reviewed by the Contracting Officer and, if found to be adequate, one approved copy will be returned to the Contractor as the basis for the Contractor's construction schedule.

J. Review comments made by NIH on the Preliminary Construction Schedule shall not relieve the Contractor from compliance with the requirements of the Contract Documents. The Contractor remains responsible for scheduling, sequencing and prosecuting the work to comply with the

requirements of the Contract documents. NIH acceptance extends only to the activities of the contractor's schedule that NIH has been assigned responsibility for and agrees it is responsible. NIH will also review for contract imposed schedule constraints and conformance, and cost loading of the CPM activities. Comments offered on other parts of the schedule which the Contractor is assigned responsibility are offered as a courtesy and are not conditions of NIH acceptance; but are for the general conformance with established industry schedule concepts.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Prepare and periodically update a comprehensive, fully developed, CPM-program based type construction schedule.

B. Basis for developing the Contractor's Construction Schedule shall be the approved Preliminary Construction Schedule including updates and feedback received since the start of construction. All requirements for the Contractor's Construction Schedule are in addition to those of the Preliminary Construction Schedule as appropriate.

C. Include each significant construction activity. Provide a separate fragnet for each Definable Feature of Work included in the Draft Contractor QC Plan required by Division 01 Section "Construction Quality Control." Coordinate each activity in the network with other activities. Schedule each activity in proper sequence. Show critical path graphically. Include the following minimum data for each activity:

1. Beginning event number.
2. Description.
3. Duration estimate.
4. Cost estimate.
5. Scheduled start date.
6. Scheduled finish date.
7. Actual start date, when applicable.
8. Actual finish date, when applicable.
9. Percent complete.

D. Schedule shall be produced by a computer program that has been developed specifically to manage construction schedules and capable of accepting revised completion dates as modified by approved time adjustments and re-computation of all tabulation dates and float accordingly. Computer program shall be capable of displaying the schedule in a variety of graphical formats including Gannt Charts and Pert Charts.

E. Cost Correlation: Provide a cost correlation line at the head of the schedule to indicate planned and actual cost. As work progresses, show dollar volume of work performed as of the dates used for applications for payment. The total of all activity costs shall equal the contract price.

F. Within each construction activity's time fragnet, indicate estimated completion percentages in not more than 5 percent increments and, as work progresses, place marks to indicate actual completion percentages.

G. Within 10 calendar days after receipt of the preliminary construction schedule, the Contracting Officer will meet with the Contractor for a joint review, correction and adjustment of the preliminary schedule.

H. Within 5 calendar days after the joint review, the Contractor shall revise the preliminary construction schedule in accordance with agreements at the joint review, and submit 3 copies of the revised Preliminary Construction Schedule to the Contracting Officer. The resubmission will be reviewed by the Contracting Officer and, if found to be adequate, one approved copy will be returned to the Contractor as the basis for the Contractor's construction.

I. Review comments made by NIH on the Preliminary Construction Schedule shall not relieve the Contractor from compliance with the requirements of the Contract Documents. The Contractor remains responsible for scheduling, sequencing and prosecuting the work to comply with the requirements of the Contract documents. NIH acceptance extends only to the activities of the contractor's schedule that NIH has been assigned responsibility for and agrees it is responsible. NIH will also review for contract imposed schedule constraints and conformance, and cost loading of the CPM activities. Comments offered on other parts of the schedule which the Contractor is assigned responsibility are offered as a courtesy and are not conditions of NIH acceptance; but are for the general conformance with established industry schedule concepts.

J. Each activity will be assigned a Schedule Activity Number.

K. Activity Duration: Define activities so no activity is longer than 21 days, unless specifically allowed by Project Officer.

L. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in the schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

M. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in the schedule. Coordinate submittal review times in the Contractor's Construction Schedule with the Submittals Schedule.

N. Sustainability Requirements: Include sustainability activities on Construction Schedule including individual milestones for documenting each LEED Credit specified in Section “Sustainable Design Requirements” as Contractor’s responsibility.

O. Startup and Testing Time: Coordinate with the commissioning requirements. Start up, testing adjusting and balancing, trend period, and functional testing by the commissioning authority shall be itemized for every system and zone (no less than at a resolution of each floor). Durations required for functional testing will be dictated by the commissioning authority. Commissioning authority will develop a Precedent Diagram to communicate the process and dictate durations for each task controlled by them.

P. Include a separate activity for each contract if work is under more than one contract.

Q. Include a separate activity for each portion of the work performed by NIH or other NIH contractors that directly impacts the work of this contract.

R. Include a separate activity for each product. Include any delivery dates indicated in Division 01, Section "Summary." Delivery dates indicated stipulate the latest possible delivery date.

S. Work Restrictions: Show the effect of the following items on the schedule:

1. Construction Risk Assessment (CRA) and Interim Life Safety Measures (ILSM) management and compliance requirements.
2. Coordination with existing construction.
3. Limitations of continued occupancies.
4. Uninterruptible services.
5. Partial occupancy before Substantial Completion.
6. Use of premises restrictions.
7. Provisions for future construction.
8. Seasonal variations.
9. Environmental control.

T. Work Stages: Indicate important stages of construction for each major portion of the work, including, but not limited to, the following:

1. Subcontract awards.
2. Submittals.
3. Purchases.
4. Mockups.
5. Fabrication.
6. Sample testing.
7. Deliveries.
8. Installation.
9. Tests and inspections.
10. Adjusting.
11. Curing.
12. Startup and placement into final use and operation.
13. Pre-occupancy HVAC flushing required by Sustainability Requirements.
14. Commissioning

U. Area Separations: Identify each major area of construction for each major portion of the work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

1. Structural and demolition completion.
2. Permanent space enclosure.
3. Completion of West Tunnel construction.
4. Completion of mechanical installation.
5. Completion of electrical installation.
6. Substantial Completion.
7. Commissioning

V. Other Constraints: None.

W. Milestones: Include milestones indicated in the Contract Documents in the schedule including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Acceptance. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

X. Updating: Provide an updated schedule in conjunction with project meeting requirements specified in Division 01 Section "Project Management and Coordination." In addition, should

actual time lines for events or activities suggest a significant change in the planned progress of the work, the contractor shall submit for Contracting Officer approval a revised schedule with justification for the change. Highlight or otherwise emphasize revisions for ease of identification.

Y. Reports: As a minimum be prepared to furnish the following computer produced reports from sorts of the basic activity data. Actual reports required and report frequency will be determined by the Project Officer.

1. Activity sort by the preceding event number from lowest to highest and then in the order of the following event number.
2. Activity sort by amount of total float, then in order of preceding event number.
3. Activity sort in order of latest allowable start dates, then in order of preceding event numbers.
4. Activity sort in order of latest allowable finish dates, then in order of preceding event numbers.
5. Activity sort by trade code, early start date and total float.
6. Contractor's monthly payment request sorted by responsibility.

Z. Float is not for the exclusive use or benefit of either NIH or the Contractor, but must be used in the best interest of completing the project on time. Extensions of time for performance required under the Contract Clauses entitled "Changes", "Differing Site Conditions", or other applicable clauses, will be granted only to the extent that the equitable time adjustment for the activity or activities affected exceeds the total float along the activities involved.

AA. Distribution: Print and distribute copies of the initial Contractor's Construction Schedule, and each updated or revised schedule, to the Contracting Officer, as well as to subcontractors and other parties required to comply with upcoming scheduled dates. Post copies in the project meeting room and temporary field office.

2.4 Submittal Schedule:

A. Prepare and submit a complete schedule of submittals to the Contracting Officer for approval. The submittal schedule shall list all submittals required by the specifications, listed in order by the specification section in which they are required. Coordinate the Submittal Schedule with the Contractor's Construction Schedule and other related documents. The Submittal Schedule shall include the following information:

1. Submittal Number.
2. Submittal Description
3. Related specification section and paragraph numbers
4. Category of Submittal (Sample, Shop Drawing, Certified Test Report, etc.)
5. Name of Subcontractor, if applicable.
6. Description of the part of the work covered by the submittal.
7. Corresponding activity or event number on the Contractor's Construction Schedule, if applicable.
8. Scheduled date for first submittal (planned and actual dates).
9. Schedule dates for resubmittal of disapproved submittals (planned and actual dates).
10. Reviewing authority (NIH, Contractor QC Manager)
11. Type of action by Contracting Officer's Technical Representative (approved; approved as noted; not approved, revise and resubmit).

12. Date of action by Contracting Officer's Technical Representative (planned and actual dates).

B. Submittals should be scheduled using the review timeframes indicated in Division 01 Section "Submittal Procedures" to maintain orderly progress of the work.

C. Submittal schedule is to be compatible with the same software system used to generate the contractor's preliminary construction schedule and contractor's construction schedule.

D. Schedule a re-submittal for each submittal using the re-submittal review timeframes indicated in Division 01 Section "Submittal Procedures."

E. Distribution: Initially submit 3 paper copies and one electronic copy of the Submittal Schedule to the Contracting Officer for review. After the Contracting Officer's response, print and distribute revised copies to the Contracting Officer and entities designated by the Contracting Officer, and to subcontractors and other parties required to comply with upcoming submittal dates.

1. Post copies in the project meeting room and temporary field office.
2. When the submittal schedule is updated, repeat distribution and posting.

F. Updating: The Submittal Schedule shall be kept up-to-date by the Contractor. A current updated copy of the Submittal Schedule shall be submitted with each Contractor payment request, and at other times as requested by the Contracting Officer, until all submittals are approved. Failure to provide the requested information, or delay in submitting required submittals may result in the payment request being returned to the Contractor until the required schedule or submittals are received.

2.5 CONTRACTOR PRODUCTION REPORT:

A. Reports are required for each day that work is performed and shall be attached to the Contractor Quality Control Report specified in Division 01 Section "Construction Quality Control" 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:

1. Date of report, report number, name of contractor, Contract number, title and location of Contract and superintendent present.
2. Weather conditions in the morning and in the afternoon including maximum and minimum temperatures.
3. Identify work performed by corresponding Schedule Activity No., PC#, Modification No., etc.
4. 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 (including hours on continuation sheets), and total work hours from start of construction.
5. A list of job safety actions taken and safety inspections conducted. Indicate that safety requirements have been met including the results on the following:

a. Was a job safety meeting held this date? (If YES, attach a copy of the meeting minutes.)
b. Were there any lost time accidents this date? (If YES, attach a copy of the completed OSHA report.)
c. Was crane/manlift/trenching/scaffold/HV electrical/high work/hazmat work done? (If YES, attach a statement or checklist showing inspection performed.)
d. Was hazardous material/ waste released into the environment? (If YES, attach a description of incident and proposed action.)

6. Identify Schedule Activity # related to safety action and list safety actions taken today and safety inspections conducted.
7. Identify Schedule Activity Number, Submittal Number and list equipment/ material received each day that is incorporated into the job.
8. Identify Schedule Activity Number, Owner and list construction and plant equipment on the work site including the number of hours used.
9. Include any meter readings.
10. Describe any emergency procedures implemented.
11. Identify significant meetings and unusual events conducted during the day.
12. 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, equipment started or tested, partial completion or Use of Occupancy granted, delays encountered and a record of visitors to the work site. For each remark given, identify the Schedule Activity Number that is associated with the remark.
13. Attach additional pages if necessary to complete the report.

2.6 MATERIAL LOCATION REPORTS:

A. At not more than weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials previously reported plus items recently delivered. Include a statement of progress on and delivery dates for materials or items or equipment fabricated or stored away from the site. Submit an electronic copy through e-mail to the Project Officer.

2.7 FIELD CONDITION REPORTS:

A. When the need to take corrective action requires a departure from the Contract Documents, the Contractor will prepare a detailed report. Include a statement describing the problem and recommended changes. Indicate reasons the Contract Documents cannot be followed. Submit a copy to the Project Officer via e-mail.

2.8 UNUSUAL EVENT REPORTS:

A. When an event of an unusual and significant nature occurs at the site, the Contractor will prepare a detailed report. List the chain of events, persons participating, response by the Contractor's personnel, evaluation of the results or effects, and similar pertinent information. Submit a copy to the Project Officer immediately. Advise the Project Officer in advance when such events are known or predictable.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.

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

B. Contractor's Construction Schedule Updating: At bi-weekly intervals, update schedule to reflect actual construction progress and activities. Issue schedule two days before progress meeting occurring during week of schedule update.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the work progresses, indicate Actual Completion percentage for each activity.
4. Retain original approved Construction Schedule baseline and include baseline indicators on each schedule update.

C. Distribution: Distribute copies of approved schedule to all parties identified by the Project Officer and the Contractor with a need-to-know schedule responsibility.

1. Post copies in project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in performance of construction activities.

### 3.2 COORDINATION

A. Coordinate Contractor's Construction Schedule with subcontractors schedules, submittals schedule, progress reports, payment requests, and other required schedules and reports.

### 3.3 COMMISSIONING FILTER

A. Contractor shall tag activities related to commissioning to facilitate printing a commissioning schedule (which shall be the main construction schedule filtered for commissioning activities). Commissioning schedule shall be updated for each commissioning meeting and discussed during those meetings.

END OF SECTION 013200

# SECTION 013220 - PHOTOGRAPHIC DOCUMENTATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for the following:

1. Pre-construction and pre-demolition photographs.
2. Periodic construction photographs.
3. Record construction photographs.
4. Demonstration and training videos

1.3 RELATED SECTIONS: This specification section is related to any and all specification sections with explicit or implicit reference to photographic documentation. Specific submittal requirements of these related specification sections are not included in this section.

### 1.4 QUALIFICATIONS

A. Pre-construction / pre-demolition and periodic construction photographs may be taken by any individual who demonstrates competency with camera. Engage a qualified photographer to take record photographs.

B. Photographer's Qualifications: Contractor's Photographer shall have an established reputation as a qualified photographer with good references and shall be regularly engaged as a professional photographer.

### 1.5 SUBMITTALS

A. Qualification Data: Submit photographer's list of completed projects with project names and addresses, and names and addresses of Owners and architects.

B. Photographic Documentation Plan: Include a photographic documentation plan section or appendix in the Quality Control Plan specified in Division 01 Section “Construction Quality Control”. The plan should include but not be limited to:

1. Proposed photographic media and equipment
2. Vantage Points
3. Photo frequency

4. Storage plan
5. Submission schedule

C. Pre-construction and Pre-demolition Photographs: Submit one digital copy of all required photographs on CD ROM within 7 calendar days of Notice to Proceed.

D. Periodic Construction Photographs: Submit one digital copy of all required photographs on CD ROM within 7 calendar days following each required set of progress construction photographs.

E. Record Photographs: Submit 3 prints of each view and one digital copy containing all images on CD ROM within 7 calendar days of Substantial Completion.

F. Digital Images: Electronically name each digital file with logical naming convention containing name of view and date of photo. Submit un-cropped images that have the same aspect ratio as the sensor. Submit un-compressed electronic files.

## PART 2 - PRODUCTS

### 2.1 PHOTOGRAPHIC MEDIA

A. Prints: Smooth surface matte color prints on commercial-grade stock

1. Size: 8 by 10 inch (200 by 250 mm).
2. Margins: White margins shall be provided on all borders.
3. Photographs shall be submitted mounted in clear vinyl sleeves in appropriately sized three ring binders.
4. Identification: Each photograph shall be labeled on the front in the bottom margin with project name and date the photograph was taken. On the back, an applied label or rubber-stamped impression shall be provided with the following information:

    a. Project name.
    b. Name, address, and telephone number of photographer.
    c. Name of Contractor.
    d. Date and approximate time the photograph was taken.
    e. Description of vantage point, including location, direction and any other information necessary for accuracy.

B. Digital Images: JPEG format with minimum sensor size of 6.0 megapixels

C. Demonstration and Training Video Format: High quality digital color video on DVD media.

D. Video Identification: Each copy shall be labeled with an applied label containing the following information:

1. Project name.
2. Name of Contractor.
3. Date video was recorded.
4. Description of training or demonstration session and equipment or system name.

## 2.2 RECORDS

A. A paper copy of all photographs is to be maintained on the project site by the contractor's quality control organization and available to NIH Project Officer during normal business hours.

# PART 3 - EXECUTION

## 3.1 COOPERATION WITH PHOTOGRAPHER

A. Contractor shall cooperate with the photographer's work, including providing auxiliary services as requested, access to the project site, and use of temporary lighting and other facilities.

## 3.2 CONSTRUCTION PHOTOGRAPHS

A. Pre-construction and Pre-Demolition Photographs: Before construction is started, take photographs of the site and surrounding properties from different points of view selected by the Project Officer.

1. Take not less than 8 photographs to show existing conditions adjacent to and within the project limits of construction, in sufficient detail to accurately record the physical conditions at the start of construction.

B. Periodic Construction Photographs: Periodically take photographs of the project's progress from different points of view. Vantage points shall be selected by the photographer unless otherwise directed by the Project Officer.

1. Frequency: Take photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each application for payment.
2. Number: Take not less than eight photographs each time, to best show the status of construction and progress since taking previous photographs.

C. Demonstration and Training Videos: Record instruction of Project Officer's personnel in the operation and maintenance of equipment and systems. Edit video to remove non-instructional conversation. Photographer shall select vantage points to best show equipment, systems, and procedures demonstrated.

END OF SECTION 013220

# SECTION 013300 - SUBMITTAL PROCEDURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes certain administrative and procedural requirements for shop drawings, coordination drawings, fire protection working plans, schedules, samples and certain other quality assurance submittals.

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to submittals. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

1.3 DEFINITIONS

A. Action Submittals: Unless specifically indicated as an “informational submittal” or as not requiring NIH approval or other action, submittals are action submittals and require NIH approval or other indicated action.

B. Informational Submittals: Written and graphic information that is indicated as not requiring NIH approval or other NIH action but rather is indicated as an informational submittal in the specifications. Informational submittals may be rejected by NIH for not complying with requirements.

C. Shop drawings: Drawings and schedules specifically prepared for the project, except for coordination drawings.

D. Coordination Drawings: See Division 01 Section "Project Management and Coordination" for definition and contract requirements.

E. Product data: Manufacturer's standard catalogs, pamphlets and other printed materials, and includes but is not limited to the following:

1. Product specifications
2. Installation instructions
3. Color charts
4. Catalog cuts
5. Rough-in diagrams and templates
6. Wiring diagrams
7. Performance curves
8. Operational range diagrams
9. Mill reports

F. Samples: Product samples of such scale to allow delivery for review, as well as field samples or mock-ups of full-size physical examples erected on-site or elsewhere, or establish a true-scale standard by which the corresponding work will be judged or a standard for compliance testing.

G. Other quality assurance submittals include materials specifically prepared for the project, except drawings and schedules, and include but are not limited to the following:

1. Design data and calculations
2. Certifications of compliance or conformance
3. Manufacturer's instructions and field reports

1.4 GENERAL SUBMITTAL REQUIREMENTS

A. Format: Each required submittal shall be submitted in both paper and electronic format.

1. Electronic format of each submittal item to be compatible with Coordination Drawings requirements identified in Division 01 Sections “Project Management and Coordination” and “Record Project Documentation” respectively.
2. Post electronic submittals to project server.

3. Submit final electronic submittals for inclusion in Project Record Documents. All submittal files to be fully indexed and hyper-linked within Record Documents.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities and with the Submittal Schedule specified in Division 01 Section "Construction Progress Documentation."

C. All submittals will be certified by the Contractor as conforming to the requirements of the contract documents prior to being forwarded to the Contracting Officer.

1. Submittals not identified as informational submittals are action submittals and require NIH approval prior to the product or item submitted being incorporated into the project.
2. Submittals identified as information submittals are informational submittals and must be submitted for information not later than 10 working days prior to the product or item submitted being shipped to site or incorporated into the work.

D. All submittals shall be transmitted to the Contracting Officer within 30 calendar days after receipt of Notice to Proceed, unless the approved Submittal Schedule specifically provides for an earlier or later submission. Transmit each submittal sufficiently in advance of the scheduled performance of related construction activities to avoid delaying the work, allowing for the review times specified in this section.

E. Coordinate each submittal with other submittals and related activities that require sequential scheduling, to allow for testing, purchase, fabrication and product delivery in a timely manner.

F. Schedule transmittal of different categories of submittals for the same Definable Feature of Work (DFOW) and for different elements of related parts of the work at the same time so as to minimize delay because of the need to review submittals concurrently for coordination. See Division 01 Section "Construction Quality Control" for definition of DFOW

1. NIH reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

G. Allow sufficient time for submittal review, corrections following the initial review and re-submittal review before activities scheduled after the submittal approval.

1. Initial submittal review: Allow 14 calendar days from receipt by NIH of the submittals for the initial review. If Design Professional’s consultants are included in the review process add an additional 7 calendar days for review.
2. Any resubmission required after NIH review shall be made within 14 calendar days after return of the submittal, unless specifically authorized otherwise by the Project Officer.
3. Re-submittal review: Allow 14 calendar days from receipt by NIH of the submittals for the initial review. If consultants are included in the review process add an additional 7 calendar days for review.
4. Special Review Timelines:

a. Provide not less than 30 calendar days for review of each fire protection submittal and re-submittal.

H. Construction will generally not be allowed to proceed without approved submittals. The Contracting Officer may, as requested in writing on a case-by-case basis, allow construction to proceed with submittal approval pending. Failure by the Contractor to provide the required submittals in a timely manner will not result in an extension to the Contractor's Construction Schedule.

I. Failure by the Contractor to provide the required submittals in a timely manner may result in progress payment requests being returned to the Contractor until submittals are up-to-date.

J. Submittal Preparation: Identify and prepare drawings and samples as specified in the Construction Contract Clauses and other specification sections. Provide a permanent label on each submittal with the following information:

1. Project name, contract number and work request number.
2. Date of submission
3. Name, address and telephone number of firm or entity that prepared the submittal.
4. Name, address and telephone number of the Contractor.
5. Name, address and telephone number of the subcontractor, supplier or manufacturer.
6. Number and title of appropriate specification section.
7. Drawing number and detail references, as appropriate.
8. Space to record Contractor's review and approval markings approximately 5 by 5 inches by 5 inches by 5 inches.
9. A blank page with a listing of all pages in the submittal shall be attached to the front of the submittal package with at least a 4 inches by 6 inches space for the NIH.

K. Submittal Transmittal: Package each submittal for transmission and handling. Transmit each submittal from the Contractor by use of a transmittal form. The following minimum information shall be included on the transmittal form.

1. Project name and number.
2. Date
3. Destination (To:)
4. Source (From:)
5. Names of subcontractor, manufacturer and supplier, as applicable.
6. Category of submittal
7. Description of submittal
8. Number and title of appropriate specification section.
9. Submittal number, including means to separately identify initial submittal and each resubmittal.
10. Certification by Contractor stating that submittal complies with the Contract Documents, or statement of deviations from the requirements of the Contract Documents including minor variations and limitations. Deviations may be listed on an attached sheet referenced on the transmittal form.
11. Signature of transmitter.

L. Direct Transmittal to Design Professionals and Engineers: Unless prohibited by the Project Officer, submittals may be transmitted directly to design Design Professional and, where specifically stipulated for certain submittals, to Design Professional’s Engineering consultants.

Provide duplicate copy of transmittal to Project Officer, and in the case of direct transmittal to Design Professional's consultants, to the Design Professional.

1. Unless indicated otherwise in above or following paragraphs, transmit all submittals to Design Professional,
2. Transmit all submittals requiring structural, mechanical, electrical, plumbing and fire protection review directly to the cognizant engineering consultant. Provide copy of transmittal to Design Professional.
3. Transmit light fixture and other electrical device submittals to Electrical Engineer with concurrent single copy of submittal to Design Professional. Provide copy of transmittal to Design Professional.
4. Transmit the following submittals to Design Professional or Design Professional's engineering consultant (as applicable) with concurrent copy to Project Officer for NIH review:

    a. Safing and firestopping
    b. Fire protection system
    c. Door hardware
    d. Electronic security system
    e. Elevator
    f. Other submittals identified by Project Officer

M. Certifications: Submit notarized certifications from the party certifying compliance of the submittal with specified requirements. Certifications shall be signed by an officer or other individual authorized to sign documents on behalf of the company certifying compliance. Certifications shall be as described in Division 01 Section "Construction Quality Control."

N. Delegated-Design Submittal: Comply with requirements in Division 01 Section "Quality Requirements."

O. Contractor's Construction Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation."

P. Submittal Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation."

## PART 2 - PRODUCTS

### 2.1 ACTION SUBMITTALS

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

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable to the project.
3. Include the following information, as applicable:

    a. Manufacturer's written recommendations.
    b. Manufacturer's product specifications.
    c. Manufacturer's installation instructions.
    d. Standard color charts.
    e. Manufacturer's catalog cuts.
    f. Wiring diagrams showing factory-installed wiring.
    g. Printed performance curves.
    h. Operational range diagrams.
    i. Mill reports.
    j. Standard product operating and maintenance manuals.
    k. Compliance with recognized trade association standards.
    l. Compliance with recognized testing agency standards.
    m. Application of testing agency labels and seals.
    n. Notation of coordination requirements.
    o. Notation of dimensions verified for fit by field measurements.

4. Number of Copies: Submit five copies of each submittal, unless otherwise indicated or concurrent NIH review is required. Submit an additional copy of MEP submittals. NIH will return three copies. Mark up and retain one returned copy as a Project Record Document. Additional copies, if submitted, will not be returned to Contractor.

C. Shop Drawings: Prepare and submit originally prepared information, drawn accurately to scale. Do not reproduce Contract Documents or copy standard printed materials as the basis for Shop Drawings and Coordination Drawings.

1. Preparation: Include the following information, as applicable:

    a. Dimensions.
    b. Identification of products and materials.
    c. Fabrication and installation drawings.
    d. Roughing-in and setting diagrams.
    e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    f. Shopwork manufacturing instructions.
    g. Templates and patterns.
    h. Schedules.
    i. Design calculations.
    j. Compliance with specified standards.
    k. Notation of coordination requirements.
    l. Notation of dimensions established by any field measurement.
    m. Highlighted or encircled deviations from the Contract Documents, if any.

2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
4. For products and installations required to be included in Coordination BIM, prepare shop drawings using specified Building Information Modeling software and coordinated properly for inclusion in the Coordination BIM.

    a. Time submittal of shop drawings as required for maximum effectiveness of Coordination BIM.

D. Number of Copies: Submit five copies of each drawing, unless otherwise indicated or concurrent NIH review is required. Submit an additional copy of MEP submittals. NIH will return three copies. Mark up and retain one returned copy as a Project Record Document. Additional copies, if submitted, will not be returned to Contractor. Contractor shall be responsible for reproduction of marked up shop drawings required for operation and maintenance manuals or other construction management purpose. Coordination Drawings: Comply with requirements in Division 01 Section "Project Management and Coordination."

E. Fire Protection Working Plan Submittals: Submit fire protection working plans, prepared in full compliance with all requirements stated in NFPA-13. Sheets shall be no smaller than 30 by 42 inches.

F. Samples: Prepare physical units of materials or products, including the following:

1. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Design Professional's sample where so indicated. Attach label on unexposed side that includes the following:

    a. Generic description of Sample.
    b. Product name or name of manufacturer.
    c. Sample source.

5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:

    a. Size limitations.
    b. Compliance with recognized standards.
    c. Availability.
    d. Delivery time.

6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.

    a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.
    b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

7. Number of Samples for Initial Selection: Submit three full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. One copy of the submittal will be returned with options selected.
8. Number of Samples for Verification: Submit four sets of Samples. Two sets will be returned.

    a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

9. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the work, or otherwise designated as Project Officer's property, are the property of Contractor.

G. Product Schedule or List: Submit a written summary indicating types of products required for the work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product.
2. Number and name of room or space.
3. Location within room or space.

## 2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections. General qualitative requirements are as specified for Action Submittals elsewhere in this section unless otherwise indicated in this Article.

1. Number of Copies: Submit two copies of each non-MEP submittal, unless otherwise indicated. Submit three copies of each MEP submittal. NIH will not return copies.
2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be

signed by an officer or other individual authorized to sign documents on behalf of that entity.

3. Test and Inspection Reports: Comply with requirements in Division 01 Section "Construction Quality Control."

B. Contractor's Construction Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation."

C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person as required in the technical specifications and in Division 01 Section "Construction Quality Control." Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

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

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

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

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

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

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

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

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

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

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

N. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

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

P. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

Q. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1. Preparation of substrates.
2. Required substrate tolerances.
3. Sequence of installation or erection.
4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

R. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

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

T. Construction Photographs: Comply with requirements in Division 01 Section "Photographic Documentation."

2.3 Material Safety Data Sheets: Submit information directly to NIH. MSDS sheets submitted directly to Design Professional will be returned.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

A. Review each submittal prior to transmission to NIH and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with certification stamp before submitting to NIH

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

### 3.2 NIH ACTION

A. Except for submittals for record or for information or for another purpose where no action and return is required, the Project Officer will review submittals and mark returned copies to indicate action taken.

B. Compliance with specified characteristics is the Contractor's responsibility, and is not part of the Contracting Officer's review and indication of action taken. No matter what review action is taken, final acceptance will depend on the contractor's full compliance with the Contract Documents.

C. Submittals that do not contain the required marking of approval by the Project Officer, as indicated in the specifications, shall not be used for construction.

D. Action Stamp: Each submittal will be stamped with a uniform action stamp. The stamp shall be marked to indicate one of the following actions taken:

1. "Approved" or "Approved as Submitted": The work covered by the submittal may proceed, provided it complies with the notations or corrections on the submittal and with the requirements of the Contract Documents.

2. "Approved as noted, Resubmission not required": The contractor is authorized to proceed with work as noted provided the contractor takes no exception to the notations.
3. "Approved as noted, Resubmission Required": The contractor is authorized to proceed with portions of the work as noted. The contractor must resubmit those items/components so noted with additional information or requirements, for approval, before work may proceed on that portion of the submittal.
4. "Disapproved": The submittal is incomplete or does not comply with design concept or requirements of the contract documents. No work shall proceed for this item until re-submittal with appropriate changes is approved.
5. "Not Reviewed": A submittal marked "not reviewed" will indicate submittal does not have evidence of being reviewed and certified by the Construction 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 which are returned for lack of review by the contractor or for being incomplete, with appropriate action, coordination, or change.
6. “Receipt Acknowledged" or no action: Submittals which are for the record or for information only or for another purpose not requiring review action.

END OF SECTION 013300

# SECTION 013550 - CONSTRUCTION SECURITY REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Other general provisions of the Construction Contract, including Contract Clauses and Section I, Provisions and other Division 01 sections apply to requirements of this Section.

### 1.2 SUBMITTALS

A. Provide a list of Contractor and Subcontractor personnel proposed to work on the Project Site as required in Article, "CONTRACTOR PERSONNEL".

B. Provide the resume and qualifications of the Construction Security Manager proposed for the project as required in Article, "CONTRACTOR PERSONNEL."

C. Vehicle Authorization Requests as required in Article, "Motor Vehicle Restrictions".

D. Electronic Security Memorandum as required in Article, "Document Control".

E. Weekly Schedule as required in Article, "Schedule".

### 1.3 GENERAL

A. The Contractor agrees on behalf of himself and all subcontractors that the following security regulations will be observed by Contractor and subcontractor personnel on the property. The Contractor shall make it a specific provision of his subcontracts that these regulations be accepted.

B. The Contractor shall be accountable for compliance with the provisions of this Section by all individuals and entities employed by or under contract to the Contractor.

C. Notification: Notify the Project Officer, or a designated representative, not less than 48 hours prior to performing work in a restricted-access area as defined by the NIH. Include the following:

1. Companies: Name of each company performing the work.
2. Personnel: Name, social security number, date and place of birth, citizenship and, where applicable, visa status of each individual who is to work.
3. Time: The exact time, date, and hours of work.
4. Areas: Specific areas of the building in which work is to be performed.

D. NIH Security Plan: All persons employed within the boundaries of the property or restricted-access areas therein, and all persons permitted to enter such property and areas shall comply with the security regulations that have been established for this Contract.

1. The Contractor will be provided with a copy of the current "Security Plan for Contractors employed by the National Institutes of Health and/or other Governmental Agencies on Behalf of the National Institutes of Health" (hereinafter called "The Security Plan" prior to commencement of the Work.

    a. The Contractor shall, within 14 days of receiving the Security Plan from The NIH, provide a copy of the Security Plan to each subcontractor or other entity to be engaged in the Project, and shall furnish evidence satisfactory to the Project Officer that this has been done.
    b. The Contractor shall maintain all current amendments or modifications of the Security Plan and shall, within 7 days of receipt from The NIH, distribute copies thereof to all holders of the Security Plan.

2. The Security Plan defines both physical and administrative security procedures for the duration of the Project. The Plan provides a guide to define the level of security required for the Project, and outlines an approach to overall security that is consistent with the goals contained in existing NIH regulations and policies.
3. The Security Plan seeks to achieve the following security goals:

    a. Screen contractor workforce consistent with NIH policies and procedures.
    b. Limit Project information distribution and Compliance with Confidentiality Non-Disclosure Certification to authorized persons and entities to the extent directed by the Division of Public Safety.

## 1.4 CONTRACTOR PERSONNEL

A. Upon commencement of the work under this Contract, the following security procedures will apply:

1. The Contractor shall provide information about all Contractor and subcontractor personnel and others who require continuing access to the site, before access is required and when access ceases.
2. No interviews of prospective Contractor employees shall be conducted within the project site or NIH property. The Contractor and subcontractors will be required to maintain a field office, outside the project site or NIH property, for all public contacts. Applicants for employment and other persons not entitled to access to the project site shall be required to contact the Contractor or subcontractor at these offices.
3. Within 10 calendar days after the award of the Contract, the Contractor shall submit a list on the Contractor's letterhead stationary of all employees, subcontractors and their employees, and others who will perform work or otherwise require access to the site. Personnel shall be listed in alphabetical order by company. The list shall include the full name, social security number and date and place of birth, citizenship and, where applicable, visa status for each individual.
4. Name of any employee added later to the original list shall be submitted with the same information on the Contractor's letterhead stationary at least 8 calendar days in advance of the date of access by the employee.
5. The Contractor shall notify the Government in writing when personnel are no longer employed by the Contractor or a subcontractor. Individual's name, social security number and date and place of birth, citizenship, visa status where applicable and company who employed the individual, shall be included.

6. Each company or entity with personnel assigned to this Project shall ensure that all such personnel undergo a personnel security screening to determine their suitability for access to NIH facilities, information and data.

    a. The Security Plan establishes two levels of contractor personnel involvement: those involved in sensitive duties; and those not involved in sensitive duties. The NIH will use two different screening processes accordingly.
    b. Completion of a background questionnaire and assorted forms ("long form screening") as well as a credit check is required for:

        1) Contractor personnel with direct management responsibilities on the Project.
        2) Contractor personnel with direct management responsibilities on the Project and/or requiring access to "Law Enforcement Sensitive" or other NIH-designated sensitive information.

    c. A police check (single, "short form" screening) is required for all other contractor personnel working on the Project.
    d. In addition to other disqualifying factors as determined by the NIH, the following shall apply:

        1) Conviction for tax evasion may disqualify contractor personnel being considered for sensitive positions.
        2) A history of acts of violence, arrests for firearms or explosives violations, illegal alien status, or any felony convictions will disqualify contractor personnel from working on this Project.

7. The Contractor shall notify the DPS Police Branch of any change in personnel assigned to the project site, including changes in employee status such as disciplinary actions, terminations of employment, civil or criminal charges, and Visa status, if applicable.
8. The NIH reserves the right to require the removal of any Contractor employee from the project site if the employee is deemed a security risk by the Division of Public Safety.
9. In order to permit the NIH Division of Police to supply badges for on-site personnel, the Contractor shall cause each individual to complete a personnel identification form. These forms will be provided by the NIH to the Contractor at the pre-construction conference. Processing of the forms will be performed by the NIH at NIH expense.
10. At a time designated by the Contracting Officer or when an individual reports to the site for work the first time, a period of at least 2 hours will be required for security processing, including review of identification forms and fabrication of a permanent badge. Personnel will then be permitted to go to work without further processing of identification forms by the Government, but at least 15 minutes should be allowed each day for signing in with security to obtain access to the site.
11. The permanent badge furnished by the NIH to each Contractor employee or other person granted access to the site will serve to authorize the wearer to enter and leave the project area. The badge must be worn so as to be clearly visible at all times when on the work site.
12. Access to other parts of the NIH property will be subject to the screening procedures applicable to visitors under the Alert Level in effect as determined by the Department of Homeland Security.
13. The badge will be retained by the individual as long as he requires continued admittance to the site, but the Contractor will arrange for its immediate return to the Government when such need ceases. Temporary or visitor badges will be provided for persons who

are identified as having an infrequent or temporary legitimate business need for access to the site.

B. Construction Security Manager.

1. Construction security manager shall be designated by the Contractor for the duration of the project. The CSM must report directly to an officer of the firm and not to the site superintendent and must be given the authority in writing to implement the designated security plan, policies, procedures and directives given by the NIH Police on the project.
2. Individual must have a minimum of 5 years experience in law enforcement or security The individual must be familiar with the requirements of the Department of Homeland Security threat levels. NIH Division of Police will define the NIH responses to the various threat levels to the successful contractor.
3. Must be fluent in English, both orally and in writing.
4. The individual must undergo a U.S. Government Background Investigation so as to receive sensitive security related information from the NIH Police.
5. The individual must be capable of understanding potential security problems, exploring issues and developing efficient and effective solutions.
6. The individual must possess good interpersonal skills and be capable of working with a variety of organizations, including the NIH, other Federal Agencies, local law enforcement, and the private sector.
7. In addition to implementing and managing the construction security program for the project, the construction security manager may perform other management-level duties within the firm.
8. The only duties and responsibilities of the construction security manager are to manage and implement the construction security program on this contract.

C. All personnel engaged on the Project will be required to execute a National Institutes of Health Confidentiality Non-Disclosure Certification.

## 1.5 SECURITY PROCEDURES

A. Upon commencement of the work under this contract, the following security procedures shall apply to the Contractor and all subcontractors.

1. Contractor personnel shall not enter the NIH campus without appropriate badge.
2. For work outside "work hours" as defined in the Contract, the Contractor shall give the Contracting Officer or his designated representative at least 3 calendar days notice. This notice is required so that security arrangements may be provided and is separate and distinct from any notices required for utility shutdown or other outages.
3. The NIH reserves the right to restrict photography of the Project or other areas of the NIH premises.

    a. Cameras are not permitted without written permission from the Contracting Officer or his designated representative. If approved, permission will be granted in writing and will provide additional guidelines.

4. In addition to these NIH security requirements, the Contractor shall observe the security requirements of the property owner.

5. Personnel may be subject to inspection of their personal effects when entering and leaving the Project Site. In addition, unscheduled inspections of personnel may be made while on site.
6. The NIH reserves the right to close down the project site and order Contractor personnel off the premises in the event of a national emergency or a shut-down, for as long as the national emergency or shut down exists. The Contractor may only return to the site with written approval from the Contracting Officer or his authorized representative.

## 1.6 MOTOR VEHICLE RESTRICTIONS

A. For motor vehicle restrictions in effect under this contract, see Section H of the Contract.

B. Vehicle authorization requests shall be required for any vehicle entering the site, and shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies and, with a permit issued by the NIH, to parking in designated areas.

C. For vehicle inspection procedures, see Section H of the Contract.

## 1.7 PARKING

A. For parking restrictions in effect under this contract, see Section H of the Contract.

## 1.8 KEY CONTROL

A. Control of keys and lock combinations is essential for NIH security. Do not allow keys to be duplicated or removed from Project Site, nor allow lock combinations to be divulged without specific written advanced authorization from Project Officer. Such loss of control, observed or suspected by Project Officer, will result in requirement to change locks involved at Contractor's expense. Provide duplicate keys and lock combinations to Project Officer, as requested for the purpose of security inspections and emergency actions; include keys/combinations needed for unrestricted access to every area and element of Project, tool boxes, parked machines, storage units, and similar items.

B. Contractor shall install permanent lock cylinders and keys as directed by the Project Officer

## 1.9 DOCUMENT CONTROL

A. The Contractor shall assume responsibility for and maintain records of distribution of all drawings, specifications and other project information. Such information shall be distributed only to those specifically with a need for them to accomplish the Work.

B. Certain documents may be marked as "Sensitive Unclassified - For Official Use Only" or "Law Enforcement Sensitive", hereinafter called "sensitive" information which may include drawings, sketches, digital photographs, exposed negatives, video, written descriptions of work requirements, and similar information. Return such information promptly to Project Officer upon request, including any copies.

1. Store all Project Information in file cabinets locked during non-business hours. Store "Sensitive" documents in separate containers with access restricted to those with a specific need for use of the information.
2. Reproduction of documents shall be kept at the minimum needed to accomplish the Work, and all copies shall be numbered and recipients recorded. "Sensitive" documents shall be returned to the NIH Project Officer when no longer needed, and the NIH will arrange for their proper disposal.
3. Limit dissemination of sensitive information on need-to-know basis.
4. Any proposed deviations from these requirements must be submitted to the Project Officer for review. Approval may or may not be granted..
5. Do not allow removal/transmission of such information from Project Site without prior written approval by Project Officer.
6. "Sensitive" documents shall be transmitted using U.S. Postal Service or any commercial services that permit delivery only after receiving signature.
7. All paper waste and electronic media such as diskettes and CDS of "Sensitive" documents shall be shredded or otherwise destroyed in a manner acceptable to the NIH.

C. Notification and Reporting: Notify both the Project Officer and the Construction Security Manager immediately when known or suspected loss/compromise of "sensitive" information or other documents, notes, drawings, sketches, reports, photographs, exposed films, or similar information has occurred which may affect the security interests of the NIH. Extend this requirement to employees and other personnel working on behalf of Contractor, and expand the responsibility to include prompt reporting of security issues, including observed efforts by unauthorized persons to gain access to sensitive information.

D. The Contractor and each sub-contractor or other entity involved in the project shall submit an electronic security memorandum describing the approach to meeting the above goals and maintaining confidentiality of project files The memorandum shall describe security within the Project, including any intrusion prevention and detection methodology.

1. The Contractor shall not proceed without written approval of the memorandum by the NIH.
2. Any requests for exceptions from these requirements shall be submitted in writing to the Project Officer for review. No entity or person shall proceed with such exception without written approval by the NIH.

E. Electronic Document Security

1. All Electronic files shall be stored in specified location following NIH standards and procedures using an Engineering Document Management Software (EDMS).
2. Each Project shall have a registry file, listing the project team with their contact information, drawing list, and Revision index stored in the same location of the other project documents.
3. Security, access and maintenance of all project engineering drawings and related documents, both scanned and electronic, shall be performed and tracked through the EDMS system.
4. All documents shall be distributed among team members, including A/E, DM, CM, and their sub-contractors with approval and knowledge of the NIH Project Officer. Three principles shall always be followed in providing information:

    a. Only give the information to those that have a need to know

b. Keep records of who received the information
c. Safeguard the information during use.

1.10 COMMUNICATION

A. Use of telephone or facsimile for communications will not be restricted except that these means shall not be used for "Sensitive" information.

B. "Sensitive" information, including drawings and other documents. May be attached to electronic mail provided commercially available encryption software compatible with Microsoft Outlook approved in advance by the NIH is used.

C. If computer area networks are used for performing administrative or technical work, electronic partitions must be installed to limit access by unauthorized personnel to electronic files. Electronic files shall be organized to allow complete purging of project files at the conclusion of the Work.

1.11 RELEASE OF INFORMATION

A. No information pertaining to the project shall be released for publication, including, but not limited to, press release, internet posting, advertisement or solicitation without prior written approval of the NIH.

1.12 SCHEDULE

A. Before the close of business at the end of each week, the Contractor shall prepare a schedule for the following week's work, including the following:

1. Specific location of work for each trade.
2. Description of work for each trade.
3. Number of persons who will be on site for each location and trade.
4. Specific impacts required, such as equipment or utility shutdowns.
5. Hours of Work.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

END OF SECTION 013550

# SECTION 014000 - QUALITY REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for the contractor's quality control program. Requirements for the Contractor to provide quality control services required by the Contracting Officer are not limited by provisions of this Section. The specific technical quality control program required for the work is defined by the combination of this section and Division 01 Section "Construction Quality Control."

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to quality requirements. Specific submittal requirements of these related specification sections are not included in this section. Product quality requirements are contained in Divisions 02 through 33. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |

| | |
|---|---|
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

## 1.3 DEFINITIONS

A. Delegated Design: Contractual requirement for Contractor to provide professional services where indicated by Contract Documents.

B. Quality Assurance: Activities, actions, and procedures performed by NIH or their designated representatives, before and during execution of the work to verify that the contractor's quality control program is producing the quality of work required by the contract documents and ensure that the construction complies with all requirements.

C. Quality Control: Tests, inspections, procedures, and related actions performed by the contractor during and after execution of the work to evaluate that completed construction complies with contract requirements. Services do not include contract enforcement activities performed by the NIH or their designated representative.

D. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Mockups establish the standard by which the remaining work will be judged.

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

## 1.4 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of the Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Contracting Officer.

## 1.5 SUBMITTALS

A. Delegated-Design Submittal: When project includes requirement for Delegated Design, in addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

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

## 1.6 QUALITY CONTROL QUALIFICATIONS

A. Qualification requirements for the specified contractor's quality control organization are included in Division 01 Section "Construction Quality Control."

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

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

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

E. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this project and with a record of successful in-service performance.

F. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this project in material, design, and extent.

G. Specialists: Certain sections of the specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirement for specialists shall not supersede building codes and similar regulations governing the work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

## 1.7 PRE-CONSTRUCTION TESTING

A. The testing agency shall perform pre-construction testing for compliance with specified requirements for performance and test methods.
   1. Contractor responsibilities include the following:
      a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Fabricate and install test assemblies using installers who will perform the same tasks for project.
      d. When testing is complete, remove assemblies; do not reuse materials on the project.
   2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality control service to the Project Officer or designated

representative with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 MOCKUPS

A. Before installing portions of the work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed work:
   1. Build mockups in location and of size indicated or, if not indicated, as directed by the Project Officer.
   2. Notify Project Officer 7 calendar days in advance of dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship using products identical to those proposed for the project.
   4. Obtain Project Officer's approval of mockups before starting fabrication, or construction of remaining work represented by the mockup.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed, unless otherwise indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Comply with Contract Doc. requirements for Division 01 Section "Cutting and Patching."

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

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

END OF SECTION 014000

# SECTION 014200 - REFERENCES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 DEFINITIONS

A. General Explanation: Specification language often includes terms that are defined elsewhere in the Contract Documents, including the Construction Contract Clauses. Certain terms are defined in this section. These definitions or explanations are not necessarily complete or exclusive, but are general for the work and may be explained more explicitly in other Sections.

B. "General Conditions" refer collectively to the Construction Contract Clauses, Labor Standards and the U.S. Department of Labor Wage Decision and Special Contract Requirements bound into the specifications.

C. "Indicated" refers to graphic representations, notes or schedules on the Drawings, or to requirements elsewhere in the Specifications or other Contract Documents. Terms such as "shown", "noted", "scheduled" and "specified" have the same meaning as "indicated" and are used to further help locate the reference, but no limitation on location is intended except as specifically stated.

D. Where "directed", "authorized", "selected", "approved", or a similar term is used in conjunction with the Contractor's submittals, applications, requests and other activities, and the specifications state that an individual other than the Contracting Officer, such as the Project Officer, Design Professional or Construction Engineer, shall provide this action, it is understood that only the Contracting Officer has this authority unless the individual stated is so authorized in writing by the Contracting Officer.

1. When the individual is so authorized by the Contracting Officer, the Contractor may still appeal the action to the Contracting Officer.
2. The Contracting Officer's decision will be final.
3. In no case shall the Contracting Officer's action be interpreted as releasing the Contractor from responsibility to fulfill the requirements of the Contract Documents.

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

F. "Project site" refers to the space available to the Contractor for performance of the Work, either exclusively or in conjunction with others performing other work.

G. "Furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembling, installation and similar operations.

H. "Government Furnished" means the Government will supply the items so referenced, with the Contractor having the responsibility of pick-up, storage, delivery to the work site and final installation.

I. "Install" describes operations at the Project site, including unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.

J. "Provide" means to furnish and install, complete in place and ready for full use.

K. The requirement for packaging, packing, marking, and preparation for shipment or delivery included in the referenced specifications will apply only to those materials and equipment that are furnished directly to the Government and not to materials and equipment that are furnished and installed by the Contractor.

L. "Installer" is the Contractor or another entity engaged by the Contractor, either directly or indirectly through subcontracting, to perform a particular construction operation at the Project site, including installation, erection, application and similar operations. Installers shall be skilled in the operations they perform. Where indicated, installers shall also be Specialists as defined in the Construction Contract Clauses.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.

M. "Owner" refers to the National Institutes of Health (NIH).

N. "Government" refers to the National Institutes of Health (NIH).

O. "Project Officer" refers to the NIH Contracting Officer's Technical Representative (COTR).

P. "Building Manager/Facility Manager" is the Government employee responsible for the administration, operation and maintenance of the building.

Q. "Construction Quality Manager" (CQM) is the individual or entity, under Contract to the Government, responsible for performing the day-to-day coordination and administration of the construction Contract, including performing field inspections, recommending approval or rejection of material and workmanship, monitoring labor and safety provisions, maintaining inspection logs and records of defects, and similar activities.

R. "Notice to Proceed" is the Contracting Officer's notification in writing to the Contractor to proceed with the individual task orders, activating the time period for construction and establishing the completion date.

## 1.3 DRAWING SYMBOLS

A. Except as otherwise indicated, symbols used on the Drawings are those symbols recognized in the construction industry for the purposes.

1. These include graphic symbols defined by "Architectural Graphic Standards", published by John Wiley & Sons, Inc., latest edition, as well as graphic symbols recommended by ASHRAE, ASME, ASPE, CSI, IEEE and similar technical organizations for the mechanical and electrical Drawings.
2. Refer uncertainties as to meaning of symbols to the Contracting Officer for clarification before proceeding.

## 1.4 INDUSTRY STANDARDS

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

B. Conflicting Requirements. Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantity or quality, comply with the most stringent requirement. Immediately refer uncertainties, and requirements that are different but apparently equal, to the Contracting Officer in writing for a decision before proceeding.

C. Minimum Quantity and Quality: The quantity or quality indicated shall be the minimum provided. The actual installation may comply exactly with the minimum quantity or quality indicated, or it may exceed the minimum levels within reasonable limits.

1. Indicated numeric values are minimum or maximum as appropriate for the context of the requirements.
2. Refer uncertainties to the Contracting Officer for a decision before proceeding.

## 1.5 ABBREVIATIONS AND ACRONYMS

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

| | | |
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| CBHF | State of California, Department of Consumer Affairs<br>Bureau of Home Furnishings and Thermal Insulation<br>www.dca.ca.gov/bhfti | (800) 952-5210<br>(916) 445-1254 |
| | www.cpsc.gov | (301) 504-0990 |
| DOC | Department of Commerce<br>www.doc.gov | (202) 482-2000 |

| | | |
|---|---|---|
| EPA | Environmental Protection Agency<br>www.epa.gov | (202) 260-2090 |
| FAA | Federal Aviation Administration<br>www.faa.gov | (202) 366-4000 |
| FCC | Federal Communications Commission<br>www.fcc.gov | (202) 418-0190 |
| FDA | Food and Drug Administration<br>www.fda.gov | (888) 463-6332 |
| GSA | General Services Administration<br>www.gsa.gov | (202) 708-5082 |
| HUD | Department of Housing and Urban Development<br>www.hud.gov | (202) 708-1112 |
| LBL | Lawrence Berkeley Laboratory<br>(See LBNL) | |
| LBNL | Lawrence Berkeley National Laboratory<br>www.lbl.gov | (510) 486-5605 |
| NCHRP | National Cooperative Highway Research Program<br>(See TRB) | |
| NIST | National Institute of Standards and Technology<br>www.nist.gov | (301) 975-6478 |
| OSHA | Occupational Safety & Health Administration<br>www.osha.gov | (202) 693-1999 |
| RUS | Rural Utilities Service<br>(See USDA) | (202) 720-9540 |
| TRB | Transportation Research Board<br>www.nas.edu/trb | (202) 334-2934 |
| USDA | Department of Agriculture<br>www.usda.gov | (202) 720-2791 |
| USPS | Postal Service<br>www.usps.com<br>www.aham.org | (202) 268-2000 |
| AI | Asphalt Institute<br>www.asphaltinstitute.org | (859) 288-4960 |
| AIA | American Institute of Architects (The) | (202) 626-7300 |

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| | www.e-architect.com | |
| AISC | American Institute of Steel Construction<br>www.aisc.org | (800) 644-2400<br>(312) 670-2400 |
| AISI | American Iron and Steel Institute<br>www.steel.org | (202) 452-7100 |
| AITC | American Institute of Timber Construction<br>www.aitc-glulam.org | (303) 792-9559 |
| ALA | American Laminators Association<br>(See LMA) | |
| ALCA | Associated Landscape Contractors of America<br>www.alca.org | (800) 395-2522<br>(703) 736-9666 |
| ALSC | American Lumber Standard Committee | (301) 972-1700 |
| AMCA | Air Movement and Control Association International, Inc.<br>www.amca.org | (847) 394-0150 |
| ANLA | American Nursery & Landscape Association<br>(Formerly: AAN - American Association of Nurserymen)<br>www.anla.org | (202) 789-2900 |
| ANSI | American National Standards Institute<br>www.ansi.org | (202) 293-8020 |
| AOSA | Association of Official Seed Analysts<br>www.aosaseed.com | (402) 476-3852 |
| APA | APA - The Engineered Wood Association<br>www.apawood.org | (253) 565-6600 |
| APA | Architectural Precast Association<br>www.archprecast.org | (941) 454-6989 |
| API | American Petroleum Institute<br>www.api.org | (202) 682-8000 |
| ARI | Air-Conditioning & Refrigeration Institute<br>www.ari.org | (703) 524-8800 |
| ASCA | Architectural Spray Coaters Association<br>www.ascassoc.com | (609) 848-6120 |
| ASCE | American Society of Civil Engineers<br>www.asce.org | (800) 548-2723<br>(703) 295-6300 |

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| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers<br>www.ashrae.org | (800) 527-4723<br>(404) 636-8400 |
| ASME | ASME International<br>(The American Society of Mechanical Engineers International)<br>www.asme.org | (800) 843-2763<br>(212) 591-7722 |
| ASSE | American Society of Sanitary Engineering<br>www.asse-plumbing.org | (440) 835-3040 |
| ASTM | American Society for Testing and Materials<br>www.astm.org | (610) 832-9585 |
| AWCI | AWCI International<br>(Association of the Wall and Ceiling Industries International)<br>www.awci.org | (703) 534-8300 |
| AWCMA | American Window Covering Manufacturers Association<br>(See WCMA) | |
| AWI | Architectural Woodwork Institute<br>www.awinet.org | (800) 449-8811<br>(703) 733-0600 |
| AWPA | American Wood-Preservers' Association<br>www.awpa.com | (817) 326-6300 |
| AWS | American Welding Society<br>www.aws.org | (800) 443-9353<br>(305) 443-9353 |
| AWWA | American Water Works Association<br>www.awwa.org | (800) 926-7337<br>(303) 794-7711 |
| BHMA | Builders Hardware Manufacturers Association<br>www.buildershardware.com | (212) 297-2122 |
| BIA | Brick Industry Association (The)<br>www.bia.org | (703) 620-0010 |
| BIFMA | BIFMA International<br>(Business and Institutional Furniture Manufacturer's Association International)<br>www.bifma.com | (616) 285-3963 |
| CCC | Carpet Cushion Council<br>www.carpetcushion.org | (203) 637-1312 |
| CCFSS | Center for Cold-Formed Steel Structures<br>www.umr.edu/~ccfss | (573) 341-4471 |

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|---|---|---|
| CDA | Copper Development Association Inc.<br>www.copper.org | (800) 232-3282<br>(212) 251-7200 |
| CEA | Canadian Electricity Association<br>www.canelect.ca | (613) 230-9263 |
| CFFA | Chemical Fabrics & Film Association, Inc.<br>www.chemicalfabricsandfilm.com | (216) 241-7333 |
| CGA | Compressed Gas Association<br>www.cganet.com | (703) 412-0900 |
| CGSB | Canadian General Standards Board<br>www.pwgsc.gc.ca/cgsb | (819) 956-0425 |
| CIMA | Cellulose Insulation Manufacturers Association<br>www.cellulose.org | (888) 881-2462<br>(937) 222-2462 |
| CISCA | Ceilings & Interior Systems Construction Association<br>www.cisca.org | (630) 584-1919 |
| CISPI | Cast Iron Soil Pipe Institute<br>www.cispi.org | (423) 892-0137 |
| CLFMI | Chain Link Fence Manufacturers Institute<br>www.chainlinkinfo.org | (301) 596-2583 |
| CPA | Composite Panel Association<br>(Formerly: National Particleboard Association)<br>www.pbmdf.com | (301) 670-0604 |
| CPPA | Corrugated Polyethylene Pipe Association<br>www.cppa-info.org | (800) 510-2772<br>(202) 462-9607 |
| CRI | Carpet & Rug Institute (The)<br>www.carpet-rug.com | (800) 882-8846<br>(706) 278-3176 |
| CRSI | Concrete Reinforcing Steel Institute<br>www.crsi.org | (847) 517-1200 |
| CSA | CSA International<br>(Formerly: IAS - International Approval Services)<br>www.csa-international.org | (800) 463-6727<br>(416) 747-4000 |
| CSI | Construction Specifications Institute (The)<br>www.csinet.org | (800) 689-2900<br>(703) 684-0300 |
| CSSB | Cedar Shake & Shingle Bureau<br>www.cedarbureau.org | (604) 820-7700 |

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| CTI | Cooling Technology Institute<br>(Formerly: Cooling Tower Institute)<br>www.cti.org | (281) 583-4087 |
| DHI | Door and Hardware Institute<br>www.dhi.org | (703) 222-2010 |
| EIA/TIA | Electronic Industries Alliance/Telecommunications Industry Association<br>www.eia.org | (703) 907-7500 |
| EIMA | EIFS Industry Members Association<br>www.eifsfacts.com | (800) 294-3462<br>(770) 968-7945 |
| EJMA | Expansion Joint Manufacturers Association, Inc.<br>www.ejma.org | (914) 332-0040 |
| FCI | Fluid Controls Institute<br>www.fluidcontrolsinstitute.org | (216) 241-7333 |
| FGMA | Flat Glass Marketing Association<br>(See GANA) | |
| FM | Factory Mutual System<br>(See FMG) | |
| FMG | FM Global<br>(Formerly: FM - Factory Mutual System)<br>www.fmglobal.com | (401) 275-3000 |
| GA | Gypsum Association<br>www.gypsum.org | (202) 289-5440 |
| GANA | Glass Association of North America<br>(Formerly: FGMA - Flat Glass Marketing Association)<br>www.glasswebsite.com/gana | (785) 271-0208 |
| GRI | Geosynthetic Research Institute<br>www.drexel.edu/gri | (215) 895-2343 |
| GTA | Glass Tempering Division of Glass Association of North America<br>(See GANA) | |
| HI | Hydraulic Institute<br>www.pumps.org | (888) 786-7744<br>(973) 267-9700 |
| HI | Hydronics Institute<br>www.gamanet.org | (908) 464-8200 |

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| HMMA | Hollow Metal Manufacturers Association<br>(See NAAMM) | |
| HPVA | Hardwood Plywood & Veneer Association<br>www.hpva.org | (703) 435-2900 |
| HPW | H. P. White Laboratory, Inc.<br>www.hpwhite.com | (410) 838-6550 |
| IAS | International Approval Services<br>(See CSA International) | |
| ICEA | Insulated Cable Engineers Association, Inc.<br>www.icea.net | (508) 394-4424 |
| ICRI | International Concrete Repair Institute (The)<br>www.icri.org | (703) 450-0116 |
| IEC | International Electrotechnical Commission<br>www.iec.ch | 41 22 919 02 11 |
| IEEE | Institute of Electrical and Electronics Engineers, Inc. (The)<br>www.ieee.org | (212) 419-7900 |
| IESNA | Illuminating Engineering Society of North America<br>www.iesna.org | (212) 248-5000 |
| IGCC | Insulating Glass Certification Council<br>www.igcc.org | (315) 646-2234 |
| ILI | Indiana Limestone Institute of America, Inc.<br>www.iliai.com | (812) 275-4426 |
| IRI | Industrial Risk Insurers<br>www.industrialrisk.com | (800) 243?8308<br>(860) 520?7300 |
| ITS | Intertek Testing Services<br>www.itsglobal.com | (800) 345-3851<br>(607) 753-6711 |
| IWS | Insect Screening Weavers Association<br>(Now defunct) | |
| KCMA | Kitchen Cabinet Manufacturers Association<br>www.kcma.org | (703) 264-1690 |
| LEED | LEED-NC, U.S. Green Building Council<br>www.usgbc.org | (202) 223-7299 |
| LGSI | Light Gage Structural Institute | (972) 370-0967 |

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| | www.loseke.com | |
| LMA | Laminating Materials Association<br>(Formerly: ALA - American Laminators Association)<br>www.lma.org | (201) 664-2700 |
| LPI | Lightning Protection Institute<br>www.lightning.org | (800) 488-6864<br>(847) 577-7200 |
| LSGA | Laminated Safety Glass Association<br>(See GANA) | |
| MBMA | Metal Building Manufacturers Association<br>www.mbma.com | (216) 241-7333 |
| MCA | Metal Construction Association<br>www.metalconstruction.org | (312) 201-0193 |
| MFMA | Maple Flooring Manufacturers Association<br>www.maplefloor.org | (847) 480-9138 |
| MFMA | Metal Framing Manufacturers Association | (312) 644-6610 |
| MGPHO | Medical Gas Professional Healthcare Organization, Inc.<br>www.mgpho.org | (877) 238-5157<br>(913) 681-6548 |
| MHIA | Material Handling Industry of America<br>www.mhia.org | (800) 345-1815<br>(704) 676-1190 |
| MIA | Marble Institute of America<br>www.marble-institute.com | (614) 228-6194 |
| ML/SFA | Metal Lath/Steel Framing Association<br>(See SSMA) | |
| MSS | Manufacturers Standardization Society of The Valve and Fittings Industry Inc.<br>www.mss-hq.com | (703) 281-6613 |
| NAAMM | National Association of Architectural Metal Manufacturers<br>www.naamm.org | (312) 332-0405 |
| NAAMM | North American Association of Mirror Manufacturers<br>(See GANA) | |
| NACE | NACE International<br>(National Association of Corrosion Engineers International)<br>www.nace.org | (281) 228-6200 |
| NAIMA | North American Insulation Manufacturers Association | (703) 684-0084 |

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| | (The)<br>www.naima.org | |
| NAMI | National Accreditation and Management Institute, Inc. | (304) 258-5100 |
| NAPM | National Association of Photographic Manufacturers<br>(See PIMA) | |
| NBGQA | National Building Granite Quarries Association, Inc.<br>www.nbgqa.com | (800) 557-2848 |
| NCMA | National Concrete Masonry Association<br>www.ncma.org | (703) 713-1900 |
| NCPI | National Clay Pipe Institute<br>www.ncpi.org | (414) 248-9094 |
| NCTA | National Cable Television Association<br>www.ncta.com | (202) 775-3669 |
| NEBB | National Environmental Balancing Bureau<br>www.nebb.org | (301) 977-3698 |
| NECA | National Electrical Contractors Association<br>www.necanet.org | (301) 657-3110 |
| NeLMA | Northeastern Lumber Manufacturers' Association<br>www.nelma.org | (207) 829-6901 |
| NEMA | National Electrical Manufacturers Association<br>www.nema.org | (703) 841-3200 |
| NETA | InterNational Electrical Testing Association<br>www.netaworld.org | (303) 697-8441 |
| NFPA | National Fire Protection Association<br>www.nfpa.org | (800) 344-3555<br>(617) 770-3000 |
| NFRC | National Fenestration Rating Council<br>www.nfrc.org | (301) 589-6372 |
| NGA | National Glass Association<br>www.glass.org | (703) 442-4890 |
| NHLA | National Hardwood Lumber Association<br>www.natlhardwood.org | (800) 933-0318<br>(901) 377-1818 |
| NLGA | National Lumber Grades Authority<br>www.nlga.org | (604) 524-2393 |

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| NOFMA | National Oak Flooring Manufacturers Association<br>www.nofma.org | (901) 526-5016 |
| NPA | National Particleboard Association<br>(See CPA) | |
| NRCA | National Roofing Contractors Association<br>www.nrca.net | (800) 323-9545<br>(847) 299-9070 |
| NRMCA | National Ready Mixed Concrete Association<br>www.nrmca.org | (888) 846-7622<br>(301) 587-1400 |
| NSA | National Stone Association<br>www.aggregates.org | (800) 342-1415<br>(703) 525-8788 |
| NSF | NSF International<br>(National Sanitation Foundation International)<br>www.nsf.org | (800) 673-6275<br>(734) 769-8010 |
| NTMA | National Terrazzo and Mosaic Association, Inc.<br>www.ntma.com | (800) 323-9736<br>(703) 779-1022 |
| NWWDA | National Wood Window and Door Association<br>(See WDMA) | |
| PCI | Precast/Prestressed Concrete Institute<br>www.pci.org | (312) 786-0300 |
| PDCA | Painting and Decorating Contractors of America<br>www.pdca.com | (800) 332-7322<br>(703) 359-0826 |
| PDI | Plumbing & Drainage Institute<br>www.pdionline.org | (800) 589-8956<br>(508) 230-3516 |
| PGI | PVC Geomembrane Institute<br>//pgi-tp.ce.uiuc.edu | (217) 333-3929 |
| PIMA | Photographic & Imaging Manufacturers Association<br>(Formerly: NAPM - National Association of Photographic Manufacturers)<br>www.pima.net | (914) 698-7603 |
| RCSC | Research Council on Structural Connections<br>www.boltcouncil.org | (800) 644-2400<br>(312) 670-2400 |
| RFCI | Resilient Floor Covering Institute<br>(Contact by mail only) | |
| RIS | Redwood Inspection Service<br>www.calredwood.org | (888) 225-7339<br>(415) 382-0662 |

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| RMA | Rubber Manufacturers Association<br>www.rma.org | (800) 220-7620<br>(202) 682-4800 |
| SAE | SAE International<br>www.sae.org | (724) 776-4841 |
| SDI | Steel Deck Institute<br>www.sdi.org | (847) 462-1930 |
| SDI | Steel Door Institute<br>www.steeldoor.org | (440) 899-0010 |
| SEFA | Scientific Equipment and Furniture Association<br>www.sefalabfurn.com | (843) 689-6878 |
| SGCC | Safety Glazing Certification Council<br>www.sgcc.org | (315) 646-2234 |
| SIGMA | Sealed Insulating Glass Manufacturers Association<br>www.sigmaonline.org/sigma | (312) 644-6610 |
| SJI | Steel Joist Institute<br>www.steeljoist.org | (843) 626-1995 |
| SMA | Screen Manufacturers Association | (561) 533-0991 |
| SMACNA | Sheet Metal and Air Conditioning Contractors'<br>National Association<br>www.smacna.org | (703) 803-2980 |
| SPFA | Spray Polyurethane Foam Alliance<br>(Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.;<br>Spray Polyurethane Foam Division)<br>www.sprayfoam.org | (800) 523-6154 |
| SPI | The Society of the Plastics Industry<br>www.plasticsindustry.org | (202) 974-5200 |
| SPIB | Southern Pine Inspection Bureau (The)<br>www.spib.org | (850) 434-2611 |
| SPI/SPFD | The Society of the Plastics Industry<br>Spray Polyurethane Foam Division<br>(See SPFA) | |
| SPRI | SPRI (Single Ply Roofing Institute)<br>www.spri.org | (781) 444-0242 |

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| SSINA | Specialty Steel Industry of North America<br>www.ssina.com | (800) 982-0355<br>(202) 342-8630 |
| SSMA | Steel Stud Manufacturers Association<br>(Formerly: ML/SFA - Metal Lath/Steel Framing Association)<br>www.ssma.com | (312) 456-5590 |
| SSPC | SSPC: The Society for Protective Coatings<br>www.sspc.org | (800) 837-8303<br>(412) 281-2331 |
| STI | Steel Tank Institute<br>www.steeltank.com | (847) 438-8265 |
| SWI | Steel Window Institute<br>www.steelwindows.com | (216) 241-7333 |
| SWRI | Sealant, Waterproofing, and Restoration Institute<br>www.swrionline.org | (816) 472-7974 |
| TCNA | Tile Council of North America, Inc.<br>www.tileusa.com | (864) 646-8453 |
| TIA/EIA | Telecommunications Industry Association/Electronic Industries Alliance<br>www.tiaonline.org | (703) 907-7700 |
| TPI | Truss Plate Institute | (608) 833-5900 |
| TPI | Turfgrass Producers International<br>www.turfgrasssod.org | (800) 405-8873<br>(847) 705-9898 |
| UFAC | Upholstered Furniture Action Council<br>www.ufac.org | (336) 885-5065 |
| UL | Underwriters Laboratories Inc.<br>www.ul.com | (800) 704-4050<br>(847) 272-8800 |
| UNI | Uni-Bell PVC Pipe Association<br>www.uni-bell.org | (972) 243-3902 |
| USITT | United States Institute for Theatre Technology, Inc.<br>www.culturenet.ca/usitt | (800) 938-7488<br>(315) 463-6463 |
| USGBC | LEED-NC, U.S. Green Building Council<br>www.usgbc.org | (202) 223-7299 |
| USP | U.S. Pharmacopeia<br>www.usp.org | (800) 822-8772<br>(301) 881-0666 |
| WASTEC | Waste Equipment Technology Association | (800) 424-2869 |

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| | www.wastec.org | (202) 244-4700 |
| WCLIB | West Coast Lumber Inspection Bureau<br>www.wclib.org | (800) 283-1486<br>(503) 639-0651 |
| WCMA | Window Covering Manufacturers Association<br>(Formerly: AWCMA - American Window Covering Manufacturers Association)<br>www.windowcoverings.org | (800) 506-4653<br>(212) 661-4261 |
| WDMA | Window & Door Manufacturers Association<br>(Formerly: NWWDA - National Wood Window and Door Association)<br>www.wdma.com | (800) 223-2301<br>(847) 299-5200 |
| WIC | Woodwork Institute of California<br>www.wicnet.org | (916) 372-9943 |
| WMMPA | Wood Moulding & Millwork Producers Association<br>www.wmmpa.com | (800) 550-7889<br>(530) 661-9591 |
| WWPA | Western Wood Products Association<br>www.wwpa.org | (503) 224-3930 |

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

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| CBHF | State of California, Department of Consumer Affairs<br>Bureau of Home Furnishings and Thermal Insulation<br>www.dca.ca.gov/bhfti<br>www.cpsc.gov | (800) 952-5210<br>(916) 445-1254<br><br>(301) 504-0990 |
| DOC | Department of Commerce<br>www.doc.gov | (202) 482-2000 |
| EPA | Environmental Protection Agency<br>www.epa.gov | (202) 260-2090 |
| FAA | Federal Aviation Administration<br>www.faa.gov | (202) 366-4000 |
| FCC | Federal Communications Commission<br>www.fcc.gov | (202) 418-0190 |
| FDA | Food and Drug Administration | (888) 463-6332 |

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

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| CBHF | State of California, Department of Consumer Affairs<br>Bureau of Home Furnishings and Thermal Insulation<br>www.dca.ca.gov/bhfti<br>www.cpsc.gov | (800) 952-5210<br>(916) 445-1254<br><br>(301) 504-0990 |
| DOC | Department of Commerce<br>www.doc.gov | (202) 482-2000 |
| EPA | Environmental Protection Agency<br>www.epa.gov | (202) 260-2090 |
| FAA | Federal Aviation Administration<br>www.faa.gov | (202) 366-4000 |
| FCC | Federal Communications Commission<br>www.fcc.gov | (202) 418-0190 |
| FDA | Food and Drug Administration<br>www.fda.gov | (888) 463-6332 |
| GSA | General Services Administration<br>www.gsa.gov | (202) 708-5082 |
| HUD | Department of Housing and Urban Development<br>www.hud.gov | (202) 708-1112 |
| LBL | Lawrence Berkeley Laboratory<br>(See LBNL) | |
| LBNL | Lawrence Berkeley National Laboratory<br>www.lbl.gov | (510) 486-5605 |
| NCHRP | National Cooperative Highway Research Program<br>(See TRB) | |
| NIST | National Institute of Standards and Technology<br>www.nist.gov | (301) 975-6478 |
| OSHA | Occupational Safety & Health Administration<br>www.osha.gov | (202) 693-1999 |
| RUS | Rural Utilities Service<br>(See USDA) | (202) 720-9540 |

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| TRB | Transportation Research Board<br>www.nas.edu/trb | (202) 334-2934 |
| USDA | Department of Agriculture<br>www.usda.gov | (202) 720-2791 |
| USPS | Postal Service<br>www.usps.com | (202) 268-2000 |

D. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized or reasonably inferable name of the entities having jurisdiction in the State in which the project is constructed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 014200

# SECTION 014500 - CONSTRUCTION QUALITY CONTROL

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for the contractor's Quality Control (QC) Program. The QC Program required for the work is defined by the combination of this section and Division 01 Section "Quality Requirements."

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to quality control. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

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| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

C. The contractor's QC Program includes tests, inspections, procedures, and related actions performed by the contractor or other contractually designated party during and after execution of the work to verify that completed construction complies with contract requirements. Services do not include contract enforcement activities performed by the NIH or their designated representative.

D. Specific QC requirements for individual construction activities are included in the technical sections that specify those construction activities.

E. The intent of this section is to describe the duties and responsibilities of the contractor's QC Program. The Contractor has the option of assembling a QC Program to match that described in this specification section or proposing an alternate program that meets the same intent. The Contractor Officer can waive all or portions of this specification if the contractor has an established proven alternative QC Program which can be documented as meeting the intent of the provisions in this specification section. The contractor is required to submit any alternate QC Program to meet the same milestones described herein and have the alternate QC Program accepted by the Contracting Officer prior to the start of work. No additional time will be allowed for the review process of an alternate program. Any costs savings resulting from an alternate QC Program will require a change order to be incorporated into the contract. No additional costs will be authorized for an alternate QC Program.

F. This specification section does not relieve the Contractor of responsibility for compliance with Contract Document requirements, and does not limit the Contractor's QC procedures that facilitate compliance with Contract Document requirements.

G. The term Contracting Officer and Project Officer shall also mean his/her representative who has been so designated in writing.

## 1.3 GOVERNING REGULATIONS AND AUTHORITIES

A. The latest edition of 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.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) ASTM A880 Criteria for Use in Evaluation of Testing Laboratories and Organization for Examination and Inspection of Steel, Stainless Steel, and Related Alloys
2. ASTM C1077 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
3. ASTM D3666 Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
4. ASTM D3740 Minimum Requirements for Agencies Engaged in the Testing and/ or Inspection of Soil and Rock as Used in Engineering Design and Construction
5. ASTM E329 Agencies Engaged in the Testing and/ or Inspection of Materials Used in Construction
6. ASTM E543 Agencies Performing Nondestructive Testing

## 1.4 QUALITY CONTROL RESPONSIBILITIES

A. Work is to be performed under the general direction of the Contracting Officer and shall be subject to inspection by the Contracting Officer's Technical Representative. No representative of the Contracting Officer is permitted to change specifications or drawings without the written authorization of the Contracting Officer.

B. The contractor shall be familiar with the latest provisions of the inspection requirements of local jurisdictions and the NIH and shall include compliance with those requirements in the work of this contract. These local provisions shall be enforced when they exceed the provisions as outlined in the specifications. The provisions of the specifications shall be considered a minimum.

C. Unless specifically indicated otherwise, the Contractor shall provide a contractor QC (QC) Program specified or required by this contract. Costs for these services are included in the Contract price.

D. The contractor's QC Program shall include but not be limited to a QC Plan, a QC Staff, specified QC meetings, a three phased QC system described in this section, submittal review and certification, specified testing, completion inspections, QC certifications and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations which comply with the requirements of this Contract.

1. The QC Program shall cover on-site and off-site work and shall be keyed to the work sequence identified in the contractor's construction schedule.
2. No work or testing may be performed unless the contractor's QC Manager is on the work site.
3. The contractor's QC Manager shall report to an officer of the firm and shall not be subordinate to the Project Superintendent or the Project Manager.
4. The contractor's QC Manager, Project Superintendent, and the contractor's management team must work together effectively. Although the QC Manager is the primary individual responsible for QC, the Contractor will ultimately be held responsible for the quality of work on the job. The project superintendent will be held responsible for the quality of production.

E. Testing and inspecting services may be required to verify compliance with requirements specified or indicated in the contract documents. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

F. Where individual technical specification sections specifically indicate that certain tests, inspections or other QC services are to be provided by a testing agency, the Contractor shall employ and pay for a qualified independent testing agency to perform the QC services.

G. Specified tests, inspections, and related actions do not limit Contractor's quality control procedures that facilitate compliance with the Contract Document requirements.

H. Where specific quality control tests or services are indicated as a NIH responsibility, the NIH will engage a qualified agency to perform these services.

1. NIH will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor and the Contract Sum will be adjusted by Change Order.

I. The Contractor shall cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. The contractor will provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field-curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

J. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

K. Coordination with the Commissioning Process: Generally for the work of Divisions 23 and 26, Contractor's QC program shall be an integral part of the commissioning process. Contractor's QC shall coordinate with the Commissioning Authority as indicated in the Division 01 Section "General Commissioning Requirements". Contractor's QC program shall execute prefunctional activities and successful completion of the QC program shall be a prerequisite of functional testing to be performed as a part of the commissioning process. Many requirements related to Contractors QC program, related to the commissioning process, are specified in the xx0800 sections of the Divisions referenced above. Contractors QC Manager(s) with the responsibility for the referenced sections shall participate in the Cx meetings and process in general.

## 1.5 SUBMITTALS

A. Submit a preliminary Definable Features of Work listing within 14 calendar days of receipt of the notice to Proceed.

B. Submit a draft Quality Control Plan within 30 calendar days following receipt the Notice to Proceed. This is independent of the collaboration with the Commissioning Authority on development of prefunctional checklists specified in Division 01 Section "General Commissioning Requirements".

C. 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.

D. Contractors should plan on a NIH review period of 14 calendar days prior to receiving comments on the draft QC Plan submission. The planned duration of the NIH review is provided as a planning figure and will vary dependent on the complexity and accuracy of the submission. No additional time will be allowed the Contractor for a NIH review longer than the above duration.

E. Submit revised Quality Control Plan within 14 calendar days following receipt of NIH comments.

1.6 CONTRACTOR'S QUALITY CONTROL ORGANIZATION

A. Quality Control Manager Duties and Qualifications

1. Provide a full time QC Manager at the work site to implement and manage the QC Program.

a. The only duties and responsibilities of the QC Manager are to manage and implement the QC Program on this contract. The QC Manager shall not be designated as the Project Superintendent or the safety competent person as defined OSHA Regulations (Standards) 29 CFR 1926.

b. 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 QC "except for those phases of control designated to be performed by QC specialists" if QC Specialists are required, perform submittal review and certification, 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 QC and documentation of work performed by "the QC specialists," if QC Specialists are required Testing Laboratory personnel and any other inspection and testing personnel required by this Contract.

1) Specific duties of the QC Manager include but are not limited to:

a) Maintains access to quality references called for in the specifications
b) Ensures all submittals are prepared, certified, and submitted as required in a timely manner to avoid project delays.
c) Coordinates changes or substitution requests made by the contractor to the Project Officer, however, he does not have the authority to approve them.
d) Inspects all work for compliance and maintains a Rework Items list on all non-conforming work.
e) Coordinates all testing requirements to maintain the production schedule.
f) Ensures that As-Built Drawings and Specifications and As-Built Record of Material documents are current and on site.
g) Coordinates submission of all miscellaneous plans required by various Division 01 specification sections to the Contracting Officer.

2) The QC Manager reports to an officer of the firm and not to the site superintendent.
3) The QC Manager has the authority and responsibility to stop the work if the work does not conform to the contract requirements. Failure to exercise this responsibility is cause for NIH directing replacement of the QC Manager.
4) Regardless who is designated as the Safety Competent Person as defined in OSHA Regulations (Standards) 29 CFR 1926.32(f) and assigned other safety responsibilities as described in Division 01 Section "Safety and Health." The QC Manager is always responsible for observing the work and monitoring safe work practices during the normal course of his jobsite duties.

2. QC Manager Qualifications.

a. A graduate of a four year accredited college program in one of the following disciplines: Engineering, Architecture, Construction Management, Engineering Technology, Building Construction, or Building Science, with a minimum of 10 years experience as a superintendent, inspector, QC Manager, project manager, 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 OSHA Regulations (Standards) 29 CFR 1926, and have experience in the areas of hazard identification and safety compliance.

B. Additional QC Management Staff Requirements. The QC requirements of this project require the QC staff to also include the following individuals:

1. Alternate QC Manager. The contractor will provide an Alternate QC Manager with similar qualifications as those of the QC Manager to serve in the event of the QC Manager's absence. The period of absence of the QC Manager shall not exceed two weeks at any one time, and not more than 30 workdays in the aggregate during a calendar year. The alternate QC Manager shall be designated in the QC Plan and should be familiar with the workings and status of the QC Program. The Alternate QC Manager may be a member of the QC staff performing other QC duties when not acting as the QC Manager.
2. QC Specialists. Provide a separate QC Specialist at the work site for each of the areas of responsibilities, indicated in the following table, who shall assist and report to the QC Manager and who shall have no duties other than their assigned QC duties. QC specialists are required to attend the Coordination and Mutual Understanding Meeting, QC meetings, and be physically present at the construction site to perform the three phases of quality control and prepare documentation for each definable feature of work in their area of responsibility at the frequency specified below.

| Area of Responsibility | Qualifications | Frequency |
|---|---|---|
| HVAC, Piping and Plumbing Systems QC Specialist | A graduate of a four year accredited college program in mechanical engineering with a minimum of 10 years experience as a superintendent, inspector, QC Manager, project manager, or construction | Daily during installation, startup and testing of systems included in area of responsibility and two days per week during pre-installation period of project. Also as necessary to attend all commissioning meetings and |

| | | |
|---|---|---|
| | manager on similar size and complexity mechanical systems installations that are part of this Contract | system hand-off meetings and to verify all prefunctional requirements of the Commissioning program have been executed and properly documented. |

3. Submittal Reviewers. Provide Submittal Reviewers, other than the QC Manager, qualified in the disciplines being reviewed, to review and certify that the submittals meet the requirements of this Contract prior to certification by the QC Manager.
4. Submittal Reviewers with specific qualifications are required for the following specification sections. Qualifications are contained in the technical specifications. The following listing is intended to be representative and may not include the compete requirement. Technical specification sections should be reviewed for additional requirements.
5. The technical specification sections may also require the presence of manufacturer or factory technical or quality representatives or engineers to be on-site prior to observe or conduct all or portions of the installation. See Division 01 Section "Quality Requirements" for individual qualifications. These representatives shall be considered an extension of the QC staff.
6. The QC Supervisor for the Pest Management Contractor (PMC) required by Division 01 Section "Temporary Facilities and Controls" shall be considered a member of the QC staff. Copies of all PMC reports will be maintained by the QC Organization and PMC activities will be included in QC Reports

## 1.7 QUALITY CONTROL PLAN

A. QC Plan Meeting: Conduct a QC Plan meeting with the Project Officer within 10 calendar days of receipt of the Notice To Proceed with the purpose of developing a mutual understanding of the QC Plan requirements prior to plan development and submission.

B. Submit a QC Plan to the Contracting Officer for approval conforming to the requirements specified elsewhere in this section within 30 calendar days after receipt of the Notice to Proceed. Coordinate submission of the QC Plan with the preparation and submission of the contractor's preliminary and final construction schedules as described in Division 01 Section "Construction Progress Documentation." The QC Plan submission should be concurrent or follow the submission of the schedule.

C. The final submission of the QC Plan should be coordinated with the submission of the contractor's construction schedule as described in Division 01 Section "Construction Progress Documentation." If the completed list of DFOWs and accepted contractor's schedule is not received within the time indicated in Division 01 Section "Construction Progress Documentation," work beyond that authorized under the "approved as noted" will not commence. The contractor will not be entitled to a contract time extension for lost time due to failure to submit a conforming QC Plan or Construction Schedule.

D. The contractor's QC Program is subject to continuous evaluation, review, and verification by the Project Officer and the Contracting Officer. Acceptance of the Contractor's QC Plan is conditional and will be predicated on satisfactory performance during the 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.

E. The Contractor will notify the Contracting Officer, in writing, of any proposed change to the submitted QC Plan, including pending changes in the QC organization personnel, a minimum of seven calendar days prior to the effective date of the proposed change. Proposed changes shall be subject to acceptance by the Contracting Officer prior to implementation.

F. QC Plan Requirements. Provide, for approval by the Contracting Officer, a QC Plan with pages numbered sequentially that covers both on-site and off-site work and includes the following:

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

    a. QC Organization
    b. Names And Qualifications
    c. Duties, Responsibility And Authority Of QC Personnel
    d. Outside Organizations
    e. Appointment Letters
    f. Submittal Procedures And Initial Submittal Register
    g. Testing Laboratory Information
    h. Testing Plan And Log
    i. Procedures To Complete Rework Items
    j. Documentation Procedures
    k. List Of Definable Features Of Work (DFOW)
    l. Procedures For Performing The Three Phases Of Control
    m. QC Personnel Matrix
    n. Procedures For Completion Inspection
    o. Appendix

2. A chart showing the contractor's QC organizational structure.
3. Names and qualifications, in resume format, for each person in the QC organization.
4. Duties, responsibilities and authorities of each person in the QC organization.
5. 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.
6. 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.
7. Copies of letters of direction signed by the QC Manager to all other QC staff outlining their duties, authorities, and responsibilities.
8. Procedures for reviewing, approving and managing submittals. Provide the names of the persons in the QC organization authorized to review and certify submittals prior to submission to the Contracting Officer.

9. Include a copy of the initial submittal of the Submittal Register per the requirements of Division 01 Section "Submittal Procedures."
10. Testing laboratory information required by the paragraphs entitled "Testing Agencies and Reports" of this section
11. 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.
12. Procedures to identify, record, track and complete rework items.
13. Documentation procedures, including proposed report formats.
14. List of definable features of work.

    a. 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.
    b. The list shall be cross-referenced to the contractor's Construction Schedule and the specification sections.
    c. For projects requiring a CPM Schedule, the list of definable features of work shall include but not be limited to all critical path activities.
    d. All activities for which this specification requires QC Specialists or special inspection personnel should also be included as separate DFOWs.
    e. Cutting and Patching activities as described in Division 01 Section "Cutting and Patching" shall be treated as separate DFOWs.
    f. All activities that can be expected to impact NIH operations will be treated as separate DFOWs including but not limited to utility outages and temporary traffic provisions.

15. Procedures for performing the three phases of quality control. For each DFOW, provide copies of the DFOWs Preparatory and Initial Phase Checklists. Each list shall include a breakdown of quality checks that will be used when performing the QC 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. The three phases of quality control are further defined in a following section of this specification.
16. Procedures for identifying and documenting the completion inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.
17. Appendix to include the anticipated miscellaneous project management and coordination plans being submitted for the project including but not limited to the following as applicable for project:

    a. Utility Service Interruption Plan
    b. Energy Conservation Plan
    c. Waste Management Plan
    d. Hazardous Waste/Waste Management Plan
    e. Heating and Cooling Plan
    f. Storm Water Management Plan (draft until State approved plan available)
    g. Integrated Pest Management Plan
    h. Severe Storm Plan
    i. Demolition Plan
    j. Photographic Documentation Plan
    k. LEED Submittals

1.8 COORDINATION AND MUTUAL UNDERSTANDING MEETING

A. After submission of the QC Plan, and prior to the start of construction, meet with the Contracting Officer to present the QC Program proposed by the contractor. 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.

B. At the meeting, the Contractor will be required to explain in detail how the three phases of quality control will be implemented for each definable feature of work.

C. As a minimum, the Contractor's personnel required to attend shall include an officer of the firm, the Project Manager, Project Superintendent, QC Manager and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities shall have a principal of the firm at the meeting.

D. Minutes of the meeting will be prepared by the QC Manager and signed by the Contractor, and the Contracting Officer (or their designated representative). A copy of the signed minutes shall be provided by the Contractor to all attendees. Repeat the coordination and mutual understanding meeting when a new QC Manager is appointed.

1.9 QC MEETINGS.

A. After the start of construction, the QC Manager shall conduct bi-weekly QC meetings at the work site with the Contractor’s project manager, project superintendent and sub-contractors’ project managers. 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 or their designated representative may attend these meetings. The QC Manager shall notify the Contracting Officer or their designated representative at least 48 hours in advance of each meeting. As a minimum, the following shall be accomplished at each meeting:

B. Review the minutes of the previous meeting;

C. 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;

D. Review the status of submittals:

1. Submittals reviewed and approved since last meeting
2. Submittals required in the near future;

E. Review the work to be accomplished in the next 4 weeks and documentation required:

1. Establish completion dates for outstanding 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. Discuss documentation required for the scheduled tasks;
6. Discuss safety requirements for upcoming activities:

F. Resolve QC and production problems:

1. Assist in resolving Request for Information issues; and

G. Address items that may require revising the QC Plan:

1. Changes in QC organization personnel
2. Changes in QC procedures.
3. Review health and safety plan
4. Other issues or topics as requested by the Project Officer.

## 1.10 THREE PHASES OF QUALITY CONTROL

A. The three phases of quality control, describes the process that forms the backbone of the required QC system. The three phases, Preparatory, Initial, and Follow up shall adequately cover both on-site and off-site work and shall include the following for each definable feature of work.

1. Preparatory Phase

a. Notify the Contracting Officer at least 2 workdays in advance of the beginning of each Preparatory Phase. This phase shall include a meeting conducted by the QC Manager and attended by Contractor’s Project Manager, the Superintendent, and the Foreman responsible for the DFOW. Document the results of the Preparatory Phase actions in the daily Contractor Quality Control Report and in the Preparatory Phase Checklist. The Preparatory Phase Meeting can be combined with the Pre-installation Conference if held.

b. Perform the following prior to beginning work on each DFOW:

1) Review each paragraph of the applicable specification sections
2) Review the Contract drawings
3) 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
4) Review the testing plan and cutting and patching plan and other miscellaneous project management and coordination plans as appropriate and ensure that provisions have been made to provide the required QC testing
5) Examine the work area to ensure that the required preliminary work has been completed. If manufacturer's field services are specified, verify that inspections have been accomplished and results noted. See Division 01 Section "Execution Requirements" for additional requirements.

6) 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
7) 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 DFOW
8) 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.
9) Review any hazardous material processes required for materials involved in the DFOW.

2. Initial Phase

a. Notify the Contracting Officer at least 2 workdays in advance of the beginning of each Initial Phase. When construction crews are ready to start work on a DFOW, conduct an Initial Phase meeting with the superintendent, and the foreman responsible for that DFOW. 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.
b. Perform the following for each DFOW:

1) Establish the quality of workmanship required
2) Resolve conflicts
3) Ensure that testing is performed as specified and as incorporated into the testing plan.
4) Check work procedures for compliance with the Safety Plan and the appropriate activity hazard analysis to ensure that applicable safety requirements are met.
5) Verify that all the requirements agreed to as a result of the Preparatory Phase have been or are being accomplished.

3. Follow-Up Phase

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

1) Ensure the work is in compliance with Contract requirements;
2) Maintain the quality of workmanship required
3) Ensure that testing is performed by the specified or approved source;
4) Ensure that rework items are being corrected
5) Perform safety inspections.
6) Ensure Preparatory and Initial Phase requirements are being met.

4. Additional Preparatory and Initial Phases. Additional Preparatory and Initial Phases shall be conducted on the same DFOWs for the following conditions:

a. If the quality of on-going work is unacceptable, if there are changes in the applicable QC organization,
b. If there are changes in the on-site production supervision or work crew,
c. If cutting or patching id required following completion of the DFOW,
d. If work on a definable feature is resumed after substantial period of inactivity, or
e. If other problems develop.

B. Notify the Contracting Officer at least two weeks prior to the start of the preparatory and initial phases if off site QC will be required.

## 1.11 SUBMITTAL REVIEW AND APPROVAL

A. The QC organization shall be responsible for reviewing and certifying that all submittals are in compliance with the contract requirements. Those submittals requiring additional NIH approval shall be certified prior to being forwarded to NIH for approval.

B. Those submittals requiring specific NIH approval are specifically identified in the technical specifications and will be forwarded for approval as described in Division 01 Section "Submittal Procedures."

C. Submittal documentation requirements for contractor QC certified submittals are identical to those of NIH approved submittals and are described in Division 01 Section "Submittal Procedures."

D. Procedures for submission, review and approval of technical submittals are described in Division 01 Section "Submittal Procedures."

## 1.12 TESTING AGENCIES AND REPORTS

A. Qualification Data: Contractor shall submit for Contracting Officer Approval each testing agency's firm name, and credentials to perform the specified services, to the NIH for the Contracting Officer's approval at least 15 calendar days before scheduled inspections or tests.

1. A qualified independent testing agency shall be an accredited entity engaged to perform tests or inspections, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those tests or inspections.
2. Testing agencies shall be acceptable to the Contracting Officer.
3. Contractor shall not employ the same testing agency engaged by NIH, unless agreed to in writing by NIH.
4. Unless other accreditation is specified in the applicable individual technical specification section, each testing agency shall be an agency pre-qualified with the experience and capability to conduct testing and inspections indicated, as documented by ASTM E 548 that specializes in types of tests and inspections to be performed or shall be recognized by the Occupational Safety and Health Administration (OSHA) in accordance with 29 CFR Part 1910.7 to test and approve equipment or materials for their safe intended use.
5. Testing agencies shall be authorized by authorities having jurisdiction to operate in the geographic location of the project.

6. 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.
7. Testing and inspecting requested by the Contractor not required by the Contract Documents are Contractor's responsibility.
8. Submit additional copies of each written test report directly to authorities having jurisdiction, when they so direct.
9. Testing agencies may not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the work.

B. Schedule of Tests and Inspections: The Contractor shall prepare and submit a comprehensive Schedule of Tests and Inspections required by the contract documents.

1. Coordinate the Schedule of Tests and Inspections with the Contractor's Construction Schedule and other related documents. Prepare in tabular form to include the following:

    a. Specification Section number and title.
    b. Description of test and inspection.
    c. Identification of applicable standards.
    d. Identification of test and inspection methods.
    e. Number of tests and inspections required.
    f. Time schedule or time span for tests and inspections.
    g. Entity responsible for performing tests and inspections.
    h. Requirements for obtaining samples.
    i. Unique characteristics of each quality-control service.

C. Test Results and Reports

1. Provide actual results in a written format in the number of copies required by the QC Manager 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 directly through the Project Officer immediately. Written test reports will include the following information:

    a. Date of issue.
    b. Project title and number.
    c. Name, address, and telephone number of testing agency.
    d. Dates and locations of samples and tests or inspections.
    e. Names of individuals making the test or inspection.
    f. Designation of the work and test method.
    g. Identifications of product and specification section.
    h. Complete test or inspection data.
    i. Test results and an interpretation of test results.
    j. Ambient conditions at the time of sample taking and testing.
    k. Comments or professional opinion on whether tested or inspected Work complies with Contract Document requirements.
    l. Name and signature of laboratory inspector.
    m. Recommendations on retesting.

2. Provide three copies to the Project Officer of each test and inspection report.

3. 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.
4. Furnish the signed reports, certifications, and other documentation to the Contracting Officer or his designated representative 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.

## 1.13 QUALITY CONTROL CERTIFICATIONS AND COMPLETION INSPECTIONS

A. QC Certifications

1. Contractor Quality Control Report Certification. Each Contractor QC Report shall contain the following statement:
2. "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." (signed by the QC Manager)
3. Invoice Certification. Furnish a certificate to the Contracting Officer with each payment request, signed by the QC Manager, attesting that Project Record Documents are current and attesting that the work for which payment is requested, including stored material, is in compliance with Contract requirements.
4. 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."

B. Completion Inspections

1. Individual DFOW Punch-Out Inspections.

    a. Near the completion of each DFOW, 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.
    b. Include in the punch list any remaining items on the "Rework Items List" which were not corrected prior to the Punch-Out Inspection.
    c. The punch lists shall include the estimated date by which the deficiencies will be corrected. A copy of the punch lists shall be provided to the Contracting Officer.
    d. The QC Manager or staff shall make follow-on inspections to ascertain that all deficiencies have been corrected.
    e. The Contractor shall notify the Contracting Officer or his designated representative when each DFOW has had all deficiencies corrected.

2. Punch-Out Inspection (prior to Pre-Final Inspection).

    a. Near the completion of all work or any increment thereof established by a contract clause 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.

b. Include in the punch lists any remaining items on the "Rework Items List" which were not corrected prior to the Punch-Out Inspection.
c. The punch lists shall include the estimated date by which the deficiencies will be corrected. A copy of the punch lists shall be provided to the Contracting Officer.
d. The QC Manager or staff shall make follow-on inspections to ascertain that all deficiencies have been corrected.
e. The Contractor shall notify the Contracting Officer or his designated representative that the facility is ready for the NIH Pre-Final Inspection.

3. Pre-Final Inspection

a. The NIH will perform this inspection to verify that the facility is complete and ready to be occupied. A NIH Pre-Final Punch List may be developed as a result of this inspection.
b. Any items noted on the Pre-Final inspection shall be corrected in a timely manner and shall be accomplished before the contract completion date or phase completion date if the project is divided into phases with separate completion dates.
c. The QC Manager shall ensure that all items on the Pre-Final Punch List are corrected prior to notifying the NIH that a Final inspection with the customer can be scheduled.

4. Final Acceptance Inspection

a. The QC Manager, the superintendent and other primary contractor management personnel, and the Contracting Officer's representative will be in attendance at this inspection. Additional NIH personnel may be in attendance.
b. 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.
c. 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 additional NIH inspection costs in accordance with the Contract Clause entitled "Inspection of Construction."
d. When the Contracting Officer takes possession of partially completed work, it will be in accordance with Contract Clause "Use and Possession Prior to Completion".

## 1.14 QUALITY CONTROL DOCUMENTATION

A. Maintain current and complete records of on-site and off-site QC Program operations and activities. QC Documentation is to be coordinated with Division 01 Sections "Construction Progress Documentation," "Photographic Documentation," and "Closeout Procedures," if included in the project specifications.

B. The Contractor shall have an identification and data retrieval system. Records, reports, drawings, submittals, and equipment shall be identified to reference the following:

1. Contract Number

2. Contract Specification Number
3. Contract Drawing Number
4. Submittal Document Number
5. Contract Change Number

C. Quality Control Site Records. Establish and maintain on the jobsite the following documentation readily available to the NIH Project Officer during all business hours.

1. All completed Preparatory and Initial Phase Checklists, arranged by specification section.
2. All milestone inspections, arranged by Activity/ Event Number.
3. Photographic Documentation
4. A current up-to-date copy of the Testing Plan and Log with supporting field test reports, arranged by specification section.
5. Copies of all contract modifications, arranged in numerical order. Also include documentation that the modified work was accomplished.
6. A current up-to-date copy of the Rework Items List.
7. Current up-to-date copies of all punch lists issued by the QC Staff of the Contractor and Sub-Contractors and all punch lists issued by the NIH.

D. 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 as described in Division 01 Section "Construction Progress Documentation."

E. 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.

1. 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 (Yes/No checkboxes).
c. If Preparatory Phase work was performed (including on-site and off-site work), identify its Schedule Activity Number and DFOW. 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 copy of the Preparatory Phase Checklist.
d. Indicate if Initial Phase work was performed (Yes/No checkboxes).
e. If Initial Phase work was performed today (including on-site and off-site work), identify its Schedule Activity No. and DFOW. 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 copy of the corresponding Initial Phase Checklist.

f. Results of the Follow-up Phase inspections held that day (including on-site and off-site work), including Schedule Activity No., the location of the DFOW, 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, QC problem areas, deviations from the QC Plan, construction deficiencies encountered, photographic documentation accomplished, 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 Number that is associated with the remark.
j. Contractor Quality Control Report certification, signature and date.

2. Attach a summary report to the last daily Contractor Quality Control Report of each month.

a. Include reference to submission of Monthly Integrated Pest Management Report.

F. Preparatory Phase Checklist. Each DFOW 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 a copy of the completed checklist to the Contractor Quality Control Report of the same date.

1. The checklist shall contain the following information:

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. DFOW, Schedule Activity Number 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 NIH Representative and indicate (Yes/No checkboxes) whether or not the NIH Rep was notified. Indicate the Names of Preparatory Phase Meeting attendees, their position and company/NIH Activity 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 any 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 an activity hazard analysis has been reviewed (Yes/No checkboxes) and comment on the review of the applicable portions of OSHA Regulations (Standards) 29 CFR 1926.
j. Meeting Comments: Note comments and remarks during the Preparatory Phase Meeting that were 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.

2. QC Manager will sign and date the checklist.

G. Initial Phase Checklist. Each DFOW 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.

1. The checklist shall contain the following information:

a. Specification Section, date of report, and Contract number shall be entered.
b. DFOW, Schedule Activity Number and Index Number 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 NIH Representative and indicate (Yes/No checkboxes) whether or not the NIH Rep was notified. Indicate the Names of Initial Phase Meeting attendees, their position and company/NIH Activity 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.

2. The QC Manager will sign and date the checklist.

H. Testing Plan and Log.

1. 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.
2. Attach a copy of the updated "Testing Plan and Log" to the last daily Contractor Quality Control Report of each month.

3. Testing Plan and Log may be an expanded version of the Testing and Inspection Schedule.

I. Rework Items List.

1. 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.
2. 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.
3. The Contractor shall be responsible for including on this list items needing rework including those identified by the Contracting Officer.

J. Record Documents.

1. The QC Manager is required to ensure the record documents including Record Drawings and Record Specifications required by Division 01 Section "Closeout Procedures" are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings.
2. Ensure each deviation has been identified with the appropriate modifying documentation (e. g. PC No., Modification No., Request for Information No., etc.).
3. The QC Manager, shall initial each deviation and each revision.
4. Upon completion of work, the QC Manager shall furnish a certificate attesting to the accuracy of the Record Documents prior to submission to the Contracting Officer.

K. Report Forms. The Project Officer will make available sample formats for the various reports required by this contract which will meet the requirements of this specification. While use of these specific formats are not required, any other format used shall contain the same information.

L. Notification of 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 Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 014500

# SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This section includes requirements for construction facilities and temporary controls, including temporary utilities, support facilities and security and protection. All costs associated with such work and subsequent removal shall be the sole burden of the Contractor. The Contractor is responsible for any repairs required to restore NIH property to original or better condition if damaged by temporary construction.

B. Temporary utilities include but are not limited to the following:

1. Temporary water service and distribution.
2. Temporary electric power and lighting.
3. Temporary heat and ventilation.
4. Temporary telephone service.
5. Temporary sanitary facilities, including drinking water.

C. Support facilities include but are not limited to the following:

1. Field offices, storage sheds and fabrication shops.
2. Temporary roads and paving.
3. Dewatering facilities and drains.
4. Temporary enclosures.
5. Temporary lifts and hoists.
6. Construction Signage.
7. Waste disposal services.
8. Other construction aids and miscellaneous services and facilities.

D. Security and protection facilities include but are not limited to the following:

1. Environmental protection.
2. Stormwater control.
3. Site enclosure fence.
4. Security enclosure and lockup.
5. Barricades, warning signs, and lights.
6. Temporary enclosures.
7. Temporary partitions.
8. Temporary Fire protection.

E. Integrated pest management services.

F. Provide temporary facilities and controls required for construction activities except, if any, for facilities and controls indicated as existing or provided by NIH or others.

G. NIH will not be responsible for any cost or use charges for temporary facilities or utilities as a basis of claims for Change Orders.

H. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to temporary facilities and controls. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

1.3 DEFINITIONS

A. Permanent Enclosure: As determined by the Project Officer, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

## 1.4 UTILITY USE CHARGES

A. The Contractor shall provide all temporary utilities which are used and required by all entities engaged in construction activities at the Project site.

B. The point at which the NIH will deliver such utilities and the quantity available are as directed by the Project Officer. The Contractor shall pay all costs incurred in connecting, converting and transferring NIH utilities to the work. The Contractor shall make connections, including providing backflow preventing devices on connections to domestic water lines, shall provide transformers, and shall make all disconnections.

C. Not withstanding any other provision in the contract documents, Contractor use of NIH utilities is contingent on the Contracting Officers approval of the following contractor developed documents:

1. Waste Management Plan
2. Energy Conservation Plan
3. Heating and Cooling Plan
4. Utility Service Interruption Plan

D. Water Service: The Contractor may use reasonable amounts of water from the existing NIH water system, without metering and without payment of use charges.

E. Sewer Service: The Contractor may use the existing NIH sewer system, without payment of use charges.

F. Electric Power Service: The Contractor may use reasonable amounts of electric power from the existing NIH electric power distribution system, without metering and without payment of use charges.

## 1.5 SUBMITTALS

A. Reports: Submit reports of tests, inspections, meter readings and similar procedures for temporary utilities.

B. Implementation and Termination Schedule: Within 15 calendar days after the date established for the submittal of the Contractor's Construction Schedule, submit a schedule indicating implementation and termination of each temporary utility. If implementation or termination will interrupt utility service outside the limit of construction include milestones for submission of outage requests in the schedule. Coordinate schedule with requirements for the Utility Service Interruption Plan contained in Division 01 Section "Project Management and Coordination."

C. Shop Drawings: Submit layout indicating location of all fencing, gate locations, and size and type of fencing and gates.

D. State of Maryland Stormwater Management requirements: Submit 2 signed copies of the proposed Sequence of Construction plan sent by the Contractor to the State of Maryland to the Project Officer. Submit 1 copy of the State of Maryland approval to the Contracting Officer.

E. Integrated Pest Management (IPM) Program. Within 14 calendar days after the date of Notice to Proceed, submit the following for approval:

1. IPM Service Plan. The plan shall include a description of the implemented pest management program during all phases of construction. Include at a minimum, the following:

    a. Grounds and ground cover for task orders which involve any exterior work.
    b. Solid waste management.
    c. Site (interior and exterior) sanitation.
    d. Other factors that contribute to pest infestation.
    e. Regularly scheduled monitoring and survey program for the identification and control of insect and rodent pests.

2. Identification of the IPM Quality Control supervisor. Include a copy of the qualification certificate and resume.
3. Copy of the Commercial Pesticide Applicators Business License.
4. Copy of Pesticide Applicators Certificates and resume for all personnel assigned to each task order.

## 1.6 QUALITY REQUIREMENTS

A. Standards and Regulations: Comply with industry standards and with applicable laws and regulations of authorities having jurisdiction, including but not limited to the following:

1. Building code requirements.
2. Health and Safety regulations.
3. Utility company regulations.
4. Police, fire department and rescue squad rules.
5. Environmental protection regulations.
6. NFPA 241 "Standards for Safeguarding Construction, Alterations and Demolition Operations".
7. ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".
8. NECA Electrical Design Library "Temporary Electrical Facilities", and NEMA, NECA and UL standards and regulations for temporary electric service. Install service in accordance with NFPA 70, "National Electric Code."
9. Maryland Pesticide Applicators Laws and Regulations.

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

## 1.7 PROJECT CONDITIONS

A. Install, operate, maintain and protect temporary facilities and controls.

1. Keep temporary services and facilities clean and neat in appearance.
2. Operate temporary services in a safe and efficient manner.
3. Relocate temporary services and facilities as needed as work progresses.

4. Do not overload temporary services and facilities or permit them to interfere with progress.
5. Provide necessary fire prevention measures.
6. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on-site.

B. Prepare a schedule indicating dates for implementation and termination of each temporary utility and incorporate into the project schedule. At the earliest feasible time, when acceptable to the Project Officer, change over from temporary services to use of permanent services and remove temporary facilities when no longer needed.

C. Temporary Use of Permanent Facilities: Contractor shall assume responsibility for the operation, maintenance and protection of each permanent service during its use as a construction facility prior to acceptance by NIH.

1. Protect permanently installed mechanical ducts and equipment to remain from dust and odors in accordance with SMACNA IAQ Guidelines for Occupied Buildings under Construction.

    a. Where possible, do not use permanently installed HVAC systems during construction. Seal all duct and equipment openings with plastic.
    b. If permanently installed HVAC system must be operated to protect finished work or to serve occupied areas of building, seal all non-essential openings with plastic and install and maintain temporary filters to protect openings required to operate.

        1) Temporary filters shall be identical in quantity, arrangement and MERV rating to specified permanent filters for each air handling and exhaust system.

D. Existing Equipment and Items: Cover or otherwise protect and provide security for existing equipment and other items that are to remain in place, to prevent soiling, damage and loss.

1. Temporarily move equipment and other items that interfere with the performance of required work. Upon completion of the work, return the equipment and items to their original location and installation condition.
2. Store equipment and other items that have been temporarily removed. Upon reinstallation, clean and, if damaged, repair or replace equipment and items to match their condition prior to removal.
3. Protect existing return air plenums above construction sites to remain by installing ceiling panels or otherwise separating plenum from construction area.
4. Protect existing mechanical ducts and equipment to remain from dust and odors in accordance with SMACNA IAQ Guidelines for Occupied Buildings under Construction.

    a. Where possible, do not use existing HVAC systems during construction. Seal all duct and equipment openings with plastic.
    b. If existing HVAC system must be operated to protect finished work or to serve occupied areas of building, seal all non-essential openings with plastic and install and maintain temporary filters to protect openings required to operate.

1) Temporary filters shall be identical in quantity, arrangement and MERV rating to specified permanent filters for each air handling and exhaust system.

## 1.8 INTERIOR CONSTRUCTION BARRIERS

A. All work within existing NIH buildings shall comply with the following requirements for Construction Barriers.

1. All work areas not completely enclosed by permanent walls shall be separated from the remainder of the building with full smoke tight dust barrier protection. The work area shall be made negative in air pressure with respect to all surrounding areas, unless otherwise indicated on the contract drawings.
2. All material used for the erection of temporary dust barriers shall consist of only noncombustible or fire retardant materials, as defined by NFPA 241. All polyethylene plastic sheeting shall be fire retardant treated, as defined by NFPA 241.
3. All dust partitions (other than partitions required around asbestos abatement areas) shall be constructed of metal studs faced with gypsum wallboard, installed from the floor to underside of slab above in areas where the contract documents indicate the ceiling to be removed. If ceiling removal is not part of the contract, extend dust partition to the finished ceiling.
4. Provide full construction barrier protection with locking doors around the construction. Provide 12 keys for each lock to the Project Officer. Where possible, entrances shall be constructed of a manufactured door and include a manufactured hydraulic door closer.
5. Carpet runners shall be installed and extend 3000 mm beyond construction entrance doors. Carpet shall be vacuumed nightly. Sweeping is not acceptable.
6. Where construction areas include food service or dumb waiters, these areas shall be separated again from the general construction area with additional full smoke tight dust barrier protection, including installation of carpet runners outside of the elevator/dumb waiter temporary enclosure.
7. The contractor shall maintain a clear safe means of emergency egress through the construction site at all times to appropriate emergency exits.

## 1.9 ACCESS ROAD DUST CONTROL

A. The Contractor's dust control methods and procedures shall be approved by the Project Officer. Dust abatement on access roads shall be with applications of gravel, water sprinklers, or similar methods or treatments approved by the Project Officer.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

A. General: Provide new or undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

B. Tarpaulins: Waterproof, fire-resistant UL labeled with flame spread rating of 15 or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

C. Water: Potable and approved by local health authorities.

D. Wood: Lumber complying with DOC PS 20 and applicable grading rules of an inspection agency certified by ALSC's Board of Review for specific use. Provide preservative treated lumber where partially or fully in contact with the earth, concrete or masonry.

E. Sign, Directory and Other Graphic Panel Materials: Unless otherwise indicated, products shall comply as follows:

1. Panels: Exterior type Grade B-B high density concrete-form-overlay plywood.
2. Paint: Exterior primer and exterior grade alkyd gloss enamel top coat.

F. Open-Mesh Fencing: Minimum 0.12 inch thick galvanized 2 inch chainlink fabric fencing with galvanized steel pipe posts, 1-1/2 inches inside diameter for line posts and 2-1/2 inches inside diameter for corner posts. At the discretion of the Project Officer, steel posts and vinyl "snow fencing", or removable chain link fencing, may be provided on a temporary basis for work areas adjacent to the project site.

1. Fence height: Minimum 8 feet.
2. Top Protection: Galvanized barbed-wire top strand.

G. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36.

H. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively.

## 2.2 EQUIPMENT

A. General: Provide new or undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended. All equipment must meet applicable local codes governing its use.

B. Water Hoses: 3/4 inch heavy duty abrasion-resistant flexible rubber hoses, 100 feet long with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electric Outlets: Properly configured NEMA-polarized outlets to prevent insertion of 110 to 120 Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light for connection of power tools and equipment.

D. Electric Power Cords: Grounded extension cords.

1. Provide hard-service cords where exposed to abrasion or traffic.

2. Provide waterproof connectors to connect separate lengths of electric cords where single lengths will not reach areas of construction activity.
3. Do not exceed safe length-voltage ratio.

E. Lamps and Light Fixtures: General service incandescent lamps of wattage required for adequate illumination.

1. Provide guard cages or tempered glass enclosures where exposed to breakage.
2. Provide exterior fixtures where exposed to moisture.

F. Unless the Project Officer authorizes the use of permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Temporary heating units that have been tested and labeled by UL, FM or another recognized trade association related to the type of fuel consumed as appropriate for the space being heated.

G. Temporary Offices: Space is allocated for temporary contractors' offices on the 14th floor of Building 10.

H. Fire Extinguishers: Hand-carried portable UL-rated fire extinguishers.

1. Class A extinguishers for temporary offices and similar spaces.
2. Class ABC dry chemical extinguishers or a combination of extinguishers of NFPA recommended classes for the exposures in other locations.
3. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent and size required by location and class of fire exposure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

A. Use qualified personnel for installation of temporary facilities.

B. Locate facilities where they will serve the project adequately and result in minimum interference with performance of construction activities. Maintain, relocate and modify facilities as required during the construction period. Contractor is responsible for scheduling in order to provide each facility ready for use when needed to avoid delay. Temporary facilities shall remain in place until no longer needed or are replaced by authorized use of completed permanent facilities.

### 3.2 TEMPORARY UTILITY INSTALLATION

A. General: The Contractor shall connect to existing services.

1. Notification to interrupt any building service and/or utility service shall be requested in writing to the Project Officer a minimum of 15 working days prior to the desired date of interruption. NIH reserves the right to refuse any request and to schedule such interruption on a later or earlier date and time which is mutually agreeable to NIH and the Contractor.
2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
3. Obtain easements to bring in temporary utilities to the site where NIH easements are not available for that purpose.

B. Water Service: Install temporary water service and distribution piping of sizes and pressures adequate for construction needs until permanent water service is in use. Sterilize water piping prior to use.

1. Provide rubber hoses as necessary to serve Project site.
2. As soon as water is required at each level, extend service to form a temporary water- and fire-protection standpipe. Provide distribution piping. Space outlets so water can be reached with a 100-foot hose. Provide one hose at each outlet.
3. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
4. Provide backflow preventors at connections to existing water service.
5. Provide pumps to supply a minimum of 30-psi static pressure at highest point. Equip pumps with surge and storage tanks and automatic controls to supply water uniformly at reasonable pressures.

C. Electric Power Service: Provide weatherproof, grounded, electric power service and distribution system of sufficient size, capacity and power characteristics for construction needs. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters and main distribution switch gear.

1. Make connections at location(s) designated by the Project Officer.
2. Feeder and branch wiring with area distribution boxes shall be located so that power is available throughout the project site by use of power cords.
3. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
4. Install all electrical devices, both temporary and permanent, in accordance with the National Electric Code.
5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

D. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions at all times.

1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system.
2. Install temporary lighting in accordance with the National Electric Code.

E. Heating and Cooling: Provide temporary heat and cooling required for the construction activities in new and existing spaces, including but not limited to curing or drying completed

installations and protecting construction from adverse effects of low temperatures and/or high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.

1. Maintain a minimum temperature of 50 degrees F in permanently enclosed portions of building for normal construction activities, and 65 degrees F for finishing activities and areas where finished Work has been installed.
2. Provide temporary heating and cooling for occupied NIH spaces as required to maintain specified temperature and product manufacturer recommended humidity levels without need to rely on existing building systems.

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

G. Heating Facilities: Except where NIH authorizes use of the permanent system, provide vented self-contained, LP-gas or fuel oil heaters with individual space thermostatic control. Do not use gasoline-burning space heaters, open flame or salamander-type heating units. All temporary heating and cooling systems shall be operated in accordance with the manufacturer's instructions.

H. Telephone Service: The Contractor shall provide temporary telephone service within the contract area only if requested in writing by the Project Officer. If required, telephone service shall be removed prior to contract completion. The Contractor shall pay all costs of service. Installation and removal of service shall be subject to the approval of the Project Officer.

I. Use of Existing NIH Toilets: Use of existing NIH toilet facilities designated by the Project Officer will be permitted. Clean and maintain facilities in a condition acceptable to the Contracting Officer and, at completion of construction, restore facilities to condition prevalent at the time of initial use.

1. Drinking -Water Facilities: Provide bottled-water, drinking-water units.

    a. Provide electric water coolers to maintain dispensed water temperature at 45 to 55 degrees F.

J. Sewers and Drainage: Where sewers are available, provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available, provide containers to remove and dispose of effluent off-site in a lawful manner.

1. Filter out excessive amounts of soil, construction debris, chemicals, oils and similar contaminants that might clog sewers or pollute waterways.
2. Connect temporary sewers as directed by the Project Officer and sewer utility officials.
3. Maintain temporary sewers and facilities in a clean, sanitary condition. Following use, promptly restore sewers and facilities to normal conditions.

K. Erosion and Sediment Control: The Contractor shall comply with all provisions of the Maryland Department of the Environment requirements for Storm Water Management, including all required submittals to the state.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Locate storage sheds and other temporary construction and support facilities for easy access and as directed by the Project Officer.
2. Provide incombustible construction for offices, shops and sheds located within the construction area or within 30 feet (9 m) of building lines. Comply with NFPA 241.
3. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to NIH.

B. Temporary Roads and Paved Areas (When located in different location than permanent pavement): Construct and maintain temporary roads and paving to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas within construction limits indicated on Drawings. Obtain authorization from the Project Officer for proposed temporary roads and paved areas not located at permanent paving locations.

1. Provide a reasonably level, graded, well-drained subgrade of satisfactory soil material, compacted to not less than 95 percent of maximum dry density in the top 6 inches.
2. Provide gravel paving course of subbase material not less than 3 inches thick; roller compacted to a level, smooth, dense surface.
3. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
4. Subject to Project Officer's approval, extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration and supervision.

C. Temporary Roads and Paved Areas (When located in same location as permanent pavement): Construct and maintain temporary roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Obtain authorization from the Project Officer for proposed temporary roads and paved areas not located at permanent paving locations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas.
3. Subject to Project Officer's approval, extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration and supervision.
4. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
5. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course.

D. Dewatering Facilities and Drains: Comply with dewatering requirements of applicable Division 33 sections for temporary drainage and dewatering facilities and operations not directly

associated with construction activities. Where feasible, use same facilities provided for the construction activities. Maintain site, excavation and construction free of water.

E. Construction Signage and Other Temporary Signs: Locate signs where indicated or directed by the Project Officer to inform the public and instruct persons seeking entrance to the project. Support exterior signs on posts or framing of steel or preservative-treated wood. All signage shall conform to the standards set forth in the DCAB Guide for Construction Site Signage.

1. Exterior Construction Site Sign: All exterior construction sites shall have at least one and not more than three site signs. Signs will be provided by the Project Officer for installation by the Contractor. The Contractor shall provide a written request to the Project Officer 21 calendar days before work starts of his need for exterior construction site signs. The signs for smaller projects and those with a construction duration of less than six months will be 3 feet by 4 feet (0.9 by 1.2 m).
2. Interior Construction Sign:

    a. All interior construction areas shall have a minimum of 2 interior construction information signs. The signs will be provided by the Project Officer for installation by the Contractor. The Contractor shall provide a written request to the Project Officer 21 calendar days before work starts of his need for the Interior Construction Signs. The signs shall be placed on site not less than 14 calendar days prior to the start of construction. The signs will be either 8 1/2 by 11 inches (2.16 by 279 mm) or 11 by 17 inches (279 by 432 mm).
    b. Construction in Progress Door Hanger Signs: Door hanger signs shall be hung on the door knobs on the outside of the entrance door(s) of the room(s) in which construction is being performed. The signs will be provided by the Project Officer for installation by the Contractor. The Contractor shall provide a written request to the Project Officer 21 calendar days before work starts of his need for the Construction in Progress signs. Include the number of signs needed. Door hanger signs shall be in place not less than 7 calendar days prior to construction. The signs are 100 x 225 mm paper.
    c. Construction in Your Neighborhood Door Hanger Signs: Door hanger signs shall be hung on the door knobs on the outside of the adjacent corridors entrance door(s) on floors above and below the room(s) that may be affected by construction. The signs will be provided by the Project Officer for installation by the Contractor. The Contractor shall provide a written request to the Project Officer 21 calendar days before work starts of his need for the Construction in Progress signs. Include the number of signs needed. Door hanger signs shall be in place not less than 7 calendar days prior to construction. The signs are 100 x 225 mm paper.

3. Hard Hat Area Sign: The entire work area under this contract is designated as a Hard Hat Area. The Contractor shall assure that all contractor personnel, vendors, and visitors utilize hard hats within the project area. The Contractor shall provide hard hat area signs at each entrance to the Project site for all construction work performed under this contract. Sign shall be approximately 450 x 600 mm, with minimum 50 mm tall lettering as follows:

HARD HAT AREA
AUTHORIZED PERSONNEL ONLY
ALL PERSONNEL ENTERING THIS
CONSTRUCTION SITE SHALL BE EQUIPPED
WITH PROPER SAFETY ATTIRE

4. Asbestos Abatement Sign: The Contractor shall provide asbestos demolition signs during any asbestos demolition and removal activities.
5. Other Temporary Signs: The Contractor shall provide all signage for temporary construction, closing of roads, parking lots, sidewalks or other areas. Signage shall conform to the standards set forth in the DCAB Guide for Construction Site Signage. A copy of the guide may be obtained from the Project Officer.
6. Do not permit installation of unauthorized signs.

F. Waste Disposal Facilities:

1. See Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material" for specific requirements related to waste disposal.
2. Provide waste-collection containers in sizes adequate to handle waste from construction operations.
3. Comply with Division 01 Section "Execution Requirements" for progress cleaning requirements.

G. Janitorial Services: Provide janitorial services on a daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas.

H. Common-Use Field Offices: Provide furnishings, equipment, telephones, data systems, temporary electrical and other appurtenant items necessary to accommodate contractors' personnel at the project site. Include furnishings and equipment for meetings of approximately twenty persons at Project site. Maintain offices clean and orderly. All facilities shall be designed to be accessible to persons with disabilities. Furnish and equip offices for use as follows:

1. Desk and chair, for each on-site member of contractors' staff.
2. Three desks and chairs for Project Officers use.
3. Four-drawer file cabinets, plan tables, plan racks, and bookcases sufficient to support project staff.
4. High speed color copier with capacity for two sided 11 by 17 inches and 8-1/2 by 11 inches (279 by 432 mm and 216 by 279 mm) copying and collating.
5. High speed, large format black and white scanner / plotter, Oce TDS 320 or equivalent.
6. Personal computer and monitor for each desk with current versions of standard Office Suite Professional software and other software as needed to successfully discharge duties and responsibilities of each staff member.
7. BIM and CAD software sufficient to perform Coordination Building Information Model and Project Record Documents for the Project.
8. Break Area with water cooler, and coffee machine and supplies, including regular and decaffeinated coffee, filters, cups, stirring sticks, creamer, sugar, and sugar substitute.
9. Furnish conference room with 20 feet x 5 feet (6.1 by 1.5 m) conference table, 25 folding chairs, 4 x 8 feet (1.2 by 2.4 m) tack board and 4 x 8 feet (1.2 by 2.4 m) white marker board.

I. Storage Sheds and Fabrication Shops: Provide sheds and shops that are sized, furnished and equipped to accommodate materials and equipment involved. Include complete temporary utility services for intended use. Sheds and shops may be open shelters or fully enclosed spaces, as appropriate for use.

J. Temporary Lifts and Hoists: When existing elevators are not available or otherwise restricted from use by construction personnel, provide facilities for hoisting materials and personnel as needed to efficiently execute the project. Truck cranes and similar devices for hoisting materials are considered "tools and equipment" and not temporary facilities.

K. Existing Elevator Usage: See Division 01 Section "Work Restrictions" for additional requirements on use of existing elevators.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

L. Existing Stair Usage: Use of existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to NIH. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work.

M. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Enforce requirements strictly and dispose of material lawfully.

1. Comply with NFPA 241 for removal of combustible waste material and debris.
2. Do not hold waste materials more than 7 days during periods when the ambient temperature remains continuously less than 80 deg F, or more than 3 days when the temperature exceeds or is expected to rise above 80 deg F.
3. Handle and properly containerize hazardous, dangerous or unsanitary waste materials separately from other waste.

## 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

B. Storm Water Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains. Comply with State of Maryland Department of the Environment requirements and approved Storm Water Management permit drawings.

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

D. Site Enclosure Fence: When excavation begins, install an enclosure fence with lockable entrance gates. Install in a manner that will prevent people, dogs and other animals from easily entering the site, except by the entrance gates.

1. Locate where indicated or, if not indicated, enclose the entire site or the portion determined sufficient to accommodate construction operations.
2. Provide either open-mesh chainlink fencing with posts set in a compacted mixture of gravel and earth, or provide 8 feet high plywood fence framed with four nominal 2-by-4 inch wood rails and preservative-treated wood posts spaced not more than 8 feet apart.
3. The Contractor shall provide a locking system, approved by the Project Officer, and the enclosure fence shall be locked at the end of every work day and at all times whenever the Contractor is not present on the site.

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

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

1. Storage: Provide a secure lockup for valuable stored materials and equipment.
2. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

G. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of types needed to protect against reasonably predictable and controlled fire losses. Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations".

1. Comply with NFPA 10 "Standard for Portable Fire Extinguishers". Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.

    a. Field Offices: Class A stored-pressure water-type extinguishers.
    b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.

2. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each access route exit or entrance.
3. Store combustible materials in containers in fire-safe locations.
4. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities and access routes. Prohibit smoking in hazardous fire-exposure areas.
5. Provide supervision of welding operations, combustion-type temporary heating units and other sources of fire ignition.
6. All required standpipe systems and sprinkler systems shall be maintained in conformity with the progress of building activity in such a manner that they are always in working order.

7. Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
8. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.
9. Notification to interrupt any fire protection system shall be requested in writing to the Project Officer a minimum of fifteen working days prior to the desired date of interruption. NIH reserves the right to refuse any request and to schedule such interruption on a later or earlier date and time which is mutually agreeable to NIH and the Contractor.

H. Permanent Fire Protection: At the earliest feasible date in each area of the Project, complete installation of the permanent fire protection facilities, including connected services, and place into operation and use. Instruct key personnel in the use of the facilities.

I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress or completed, from exposure, inclement weather, other construction operations and similar conditions.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions or unacceptable effects.
2. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
3. Vertical Openings: Close openings of 25 sq. ft or less with plywood or similar materials.
4. Horizontal Openings: Close openings through floor or roof decks and other horizontal surfaces with load-bearing wood-framed construction.
5. Where enclosure exceeds 100 sq. ft. in area, use UL labeled fire-retardant-treated wood and plywood for framing and sheathing.

J. Safety: The contractor shall protect the integrity of any installed safety systems or personnel safety devices. If entrance into systems serving safety devices is required, the Contractor shall obtain prior approval from the Project Officer. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish contract requirements, the Contractor shall provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and shall obtain prior written approval from the Project Officer.

## 3.5 INTEGRATED PEST MANAGEMENT (IPM)

A. Integrated Pest Management (IPM) services for the control of pests are required on construction sites during all phases of construction. These services are to provide exclusion and control of pests while minimizing the use of pesticides. The Construction Contractor shall retain the services of a licensed and certified pest management contractor (PMC) to provide proactive IPM services, identify inadequate site sanitation and facility deficiencies during the duration of the contract. The PMC and all pest management personnel assigned to the contract must understand the principles and practices of urban IPM. The PMC must recognize that the facility

in which they are working may support sensitive biomedical research which can not be compromised through pest infestation or the improper use of toxicants, such as pesticides.

1. IPM services shall include all invertebrate and vertebrate pests including, but not limited to, cockroaches, ants (including carpenter ants), fleas, stinging insects and nests accessible from the ground or windows, rats and mice, flies, silverfish, stored product pests, raccoons, opossums, pigeons, and incidental invaders, (i.e., crickets, earwigs, midges, millipedes, centipedes, ground beetles, clover mites, birds, and bats).
2. Preventive caulking and sealing of pest harborage and pathways is the preferred method of correcting or controlling an infestation. The PMC shall review the construction contract plans and specifications and shall document whether the application of sealants and other exclusion materials under sinks, around cabinets, pipe chases, windows and doors, and the exterior, etc. have been indicated on the contract documents. The project-specific recommendations shall be submitted in writing concurrently to the Construction Contractor, Contracting Officer, and Project Officer for their review and action.

B. Personnel

1. The PMC shall designate a Quality Control Supervisor who is a manager/supervisor in the PMC firm and who will have primary responsibility for the performance of the IPM program.

    a. The Quality Control Supervisor shall perform a thorough review of all pertinent construction plans and specifications, survey the site and the surrounding grounds, survey all portions of a building involved, and meet with the Project Officer, Construction Contractor, and contractor's QC Manager to discuss the IPM service requirements.
    b. The PMC QC Supervisor shall participate in preconstruction meetings and QC meetings as appropriate.
    c. The PMC QC Supervisor shall be considered a member of the contractor's QC Staff and coordinate activities with the contractor's QC Manager. See Division 01 Section "Construction Quality Control" for additional coordination information.

2. Pest management services shall be performed only by technicians Certified by the Maryland Department of Agriculture in Category VII-General and Rodent Control. In addition, the PMC shall designate an alternate technician who is Certified by the Maryland Department of Agriculture in Category VII-General and Rodent Control. The alternate shall be familiar with all aspects of this program. Copies of certificates and the PMC's Maryland Department of Agriculture Pesticide Business License shall be kept in the PMC logbook at the work site.

C. The PMC shall develop a written IPM service plan that describes the pest management program in effect during all phases of construction. The service plan shall include recommendations concerning the grounds and existing ground cover, solid waste management, and site sanitation, and other factors that contribute to pest infestation. This plan shall also designate a day and time that the PMC shall perform pest management services. A copy of this report shall be kept with the PMC logbook at the work site. IPM services shall consist of the following:

1. Bi-weekly survey of the grounds, trailers, and building site for pest activity, structured so that all interior space and the surrounding grounds are surveyed at least once each month. The PMC shall survey the site using visual inspections, and by placing traps and other

pest monitoring devices in areas where pests may live or forage. Traps shall be identified with the technician's initials, date, and location on the site. Sticky traps shall be maintained in all areas, where feasible, throughout the construction process.

2. Reports: Sanitation and poor housekeeping practices that may contribute to pest infestations shall be reported, in writing, to the Project Officer and the Construction Contractor at the completion of each service. Submission of these reports shall be coordinated through the contractor's QC Manager.
3. Pest Management Logbook: A copy of all reports shall be kept in a pest management logbook in the Construction Contractors QC office. The logbook shall contain clear and concise records reflecting the following:

    a. Common name(s) of pests. Codes for pests shall not be permitted.
    b. Location(s) of pest activity.
    c. Common names of pesticides used (as required by the Maryland Pesticide Applicators Law and Regulations). Codes for pesticides shall not be permitted.
    d. Structural and sanitation deficiencies.
    e. Recommendations regarding pest management.
    f. Non-pesticidal control measures applied.
    g. MSDS and labels for all products that may be applied.
    h. A site map indicating the location of rodent activity and rodent control devices used on the site.
    i. A section of the Pest Management Logbook shall be allocated for construction personnel to record pest sightings.

4. Monthly Reports: At the end of each month the PMC Quality Control Supervisor shall prepare a written report summarizing pest management activities at the site. This report shall be submitted to the Contracting Officer, with copies sent to the Project Officer and Construction Contractor. The report shall be referenced in the monthly QC report prepared by the construction contractor's QC Manager. The report shall contain information on the following:

    a. Types of pests encountered, pest numbers and locations.
    b. Pesticides applied, amounts and locations.
    c. Sanitation and structural deficiencies.
    d. Non-chemical methods applied.
    e. Recommendations regarding pest management issues.

5. Progress Meetings: The PMC technician and Quality Control Supervisor shall be available, as needed, to attend progress meetings as specified in Division 01 Section "Project Management and Coordination" and "Construction Quality Control" to discuss program activities.
6. Special Service and Emergency Requests: The PMC shall respond to special service requests within one (1) working day of the request from NIH or Construction Contractor. The PMC shall provide emergency service on the same day of the request and be capable of performing emergency services when construction work is on-going. A list of telephone and pager numbers (along with instructions) shall be included in the logbook. The date and time of emergency service and the pest(s) requiring emergency service shall be listed in the logbook and monthly summary report.

D. Pesticide Use. Pesticide applications shall be made only to areas of known pest infestation or activity and where alternative control measures such as traps, caulking, sealing, cleaning and

disposal of goods were not successful or are not feasible. Because of the odor associated with some pesticides, indoor treatments shall only be performed after notification is given to Project Officer. If necessary, the PMC shall schedule pesticidal treatments for a later time and/or date in order to accommodate the needs of the site personnel and management. Insecticides shall be applied using crack and crevice injection devices, such as Whitmire System III, or other aerosols with injection tips. Granular formulations and compressed air sprayers shall only be used for treatment of utility areas or areas outside the building to correct pest problems. Pesticides permitted for use are listed below. Any products proposed for use that are not on the list require the written approval of the NIH Pest Management Unit through the Contracting Officer.

1. chlorpyrifos
2. hydramethylnon
3. avermectin
4. boric acid
5. gencor
6. methoprene
7. cholecalciferol
8. silica gel
9. Diazinon
10. pyrethrins and pyrethroids
11. brodifacoum (place packs)
12. sulfluramid
13. Chlorophacinone-Liphadione or Diphacinone Tracking Powder
14. Fipronil
15. The use of zinc phosphide is prohibited.

E. Rodent Control: Rodent control shall be on-going throughout the entire construction period. The primary focus of this program is preventive rodent management with emphasis placed on site sanitation, exclusion, and continuous surveillance of the entire site. At a minimum it shall consist of the following:

1. Thorough monitoring of all construction areas including the building interior, perimeter and grounds of the construction site. Monitoring shall consist of using traps, visual inspections for burrows and other signs of activity, and interviewing site personnel. The PMC shall collect and dispose of all dead rodents immediately.
2. Rodenticide baits shall only be applied outside the structure using "place-packs" or "bait blocks" in bait stations, labeled with the common name of the rodenticide applied and date of service, or applied directly in the burrow. The location of each bait station shall be identified on the site map located in the logbook. The use of tracking powder rodenticides shall be limited to the exterior areas. Rodent burrows that have been treated with a rodenticide shall be sealed with newspaper or by closing the burrow opening.
3. Known or suspected rodent activity in areas surrounding the construction site shall be reported to the Project Officer immediately.
4. Rodent management inside the structure shall consist of using rodent traps and glueboards. The use of grain based rodenticides is discouraged because of the potential odor problems caused by dead rodents and infestation by stored product pests in walls and other inaccessible places. If special circumstances arise the PMC may request permission from the NIH Pest Management Unit to use rodenticides inside the building.
5. Traps and glueboards shall be placed in areas where they will not be removed or pose a hazard to the construction personnel. Traps and monitoring devices should be checked

during each regular service to assure adhesiveness of the surface. If repeating live traps are used, they shall be serviced the next day to ensure quick removal of the trapped animal.

F. Post-Construction Survey and Clearance: Prior to final acceptance of the facility by NIH, the PMC shall perform a complete and thorough survey of the building(s) and grounds involved with the individual task order. The PMC will perform all necessary pest control operations inside the facility and on the grounds to control pest activity. Upon completion of this service the PMC shall issue written clearance certification for the building and grounds, with a thirty (30) day guarantee, under which the PMC will return to correct any pest problems without charge. Termites and other Wood Destroying Organisms are excluded from this requirement.

## 3.6 OPERATION, TERMINATION, AND REMOVAL

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

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect underground lines from damage during excavation operations.

C. Temporary Facility Changeover: Except for using permanent fire protection facilities as soon as available, do not change over from temporary protection facilities until authorized by the Project Officer.

D. Termination and Removal: Unless the Project Officer requests that a temporary facility be maintained longer, each temporary facility shall be removed when the need for its service has ended, when it can be replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are the property of the Contractor, except NIH reserves the right to take possession of project identification signs.
2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for subsoil or fill in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, in accordance with the requirements of the governing authority.

## 3.7 TEMPORARY CONDITIONING AND OPERATION USING PERMANENT EQUIPMENT

A. Contractor shall only use building permanent equipment to provide temporary conditioning on the approval of the AE, NIH and the Commissioning Authority (CA). Approval for such will only be given upon acceptance of a detailed plan provided by the individually involved subcontractors and compiled by the CM. The temporary conditioning plan shall consider/address the following at a minimum.

B. Indicate that the full start up protocol as required by the specification for final acceptance will be performed for the temporary start up. Temporary conditioning plan shall include the start up forms to be used which will be the same as those that will be used for final start up.

C. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address.

1. Temporary filtering of air: Temporary filters used during construction shall be identical in quantity, arrangement and MERV rating to specified permanent filters for each air handling and exhaust system. Contractor shall remove construction filters and replace with new filters at substantial completion. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a magnehelic for visual indication of pressure drop as well as set up the loaded filter DP switch for monitoring on the BAS.
2. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Strainer shall be finer than specified for final strainers.
3. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Generally return or exhaust systems shall not be used during construction unless otherwise approved. Seal ducts in accordance with SMACNA IAQ Guidelines for Occupied Buildings under Construction.
4. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer’s instructions. Contractor shall coordinate lubricants used with NIH’s operators. Frequency of lubrication and inspection shall be as recommended by manufacturer's literature. Applicable maintenance lubrication schedules shall be included in the plan. Draft maintenance logs shall be submitted with plan and completed as maintenance is performed.
5. Operation outside of Normal ranges: Systems and equipment shall not be operated outside the range of specified conditions. Plan shall address how the contractor will ensure that operation will not harm the equipment.
6. Emergency Condition Identification and Response protocols: Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safeties and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is a automatic communication/enunciation medium such as a phone connection or an internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the contractor’s 24 hour monitoring service and to the Project Officer’s help desk. The contractor shall respond to and be responsible for securing conditions within the building. Project Officer shall assess the situation and as necessary secure utilities feeding the building from isolation points outside of the building.

D. Campus Utility Impact: The plan shall address the expected impact on the campus utilities involved in the temporary conditioning equipment. Specifically address:

1. How the systems will be controlled to both ensure they are operating in range, and to avoid energy waste or inefficient conditions.
2. Project the range of loads and flows to be imposed on the campus systems. For cooling, indicated how you will ensure a temperature split of at least 8C.
3. For campus chilled water connections, the bridge connection and automatic control of the bridge related sequences shall be installed, functional and tested.

E. Building Protection: Address how the system will be controlled to avoid humidity conditions that will either promote mold growth or cause corrosion.

F. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be re-conditioned to new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.

G. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned at final turn over.

H. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Project Officer on a frequency specified by them.

I. Operating System Alterations: Plan shall address specific protocol for doing work the systems.

J. Any material, device, component, equipment, etc. that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the contractor at no cost to the contract.

K. Segregation: Where only portions of a system are to be used, contractor shall specifically indicate how the used portion will be isolated from the unused portion. Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

END OF SECTION 015000

**SECTION 015480 - USE, HANDLING, STORAGE, TRANSPORTING, ACCUMULATION AND DISPOSAL OF NIH CONTROLLED MATERIAL**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section covers the demolition, use, handling, storage, transporting, accumulation and disposal of hazardous or recyclable materials/substances/chemicals that may be encountered or that may be used by the Contractor during the course of the work. The Contractor is made aware by this specification that hazardous or recyclable materials/substances/chemicals are regulated by a multitude of statutes and regulations and require special care.

B. Only hazardous and recyclable materials and wastes generated or removed during this construction contract at NIH will be disposed of by the Contractor.

C. Hazardous wastes belonging to NIH will be disposed of by NIH. The Contractor shall notify the Contracting Officer when NIH owned hazardous wastes are discovered and/or become necessary to be removed from the project site.

D. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to project management and coordination. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |

| | |
|---|---|
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

E. Additional Requirements: Refer to the individual technical specification sections for additional requirements for the use, handling, storage, transporting, accumulation and disposal of NIH controlled material.

## 1.3 REFERENCES

A. In addition to publications referenced in the Construction Contract Clauses, the following publications designate and define hazardous materials and conditions, and establish procedures for handling these materials and conditions. Omission of any publication in this section does not remove any obligation or legal requirement on the part of the contractor to comply with all legal requirements for the location of the work.

1. Code of Federal Regulations (CFR):

   a. 29 CFR, Part 1910: Occupational Safety and Health Administration (OSHA) General Industry and Health Standards.
   b. 29 CFR, Part 1910.134: Respiratory Protection
   c. 29 CFR, Part 1910.145: Specifications for Accident Prevention Signs and Tags
   d. 29 CFR, Part 1910.20, Sub-part C: General Safety and Health Provisions
   e. 40 CFR, Part 61: National Emissions Standards for Hazardous Air Pollutants
   f. 40 CFR, Parts 9 and 82: Protection of Stratospheric zone (CFCs), Clear Air Act Amendments of 1990
   g. 40 CFR, Part 122 and 125: National Pollutant Discharge Elimination System Clean, Water Act
   h. 40 CFR, Parts 260 - 272: Solid and Hazardous Wastes, Resource Conservation and Recovery Act
   i. 40 CFR, Part 165: Disposal and Storage of Pesticides and Pesticide Containers
   j. 40 CFR, Subchapter J, Parts 300 - 373, Superfund Emergency Planning, and Community Right-to-Know Programs
   k. 40 CFR, Parts 700 - 799: Toxic Substances Control Act (TSCA)
   l. 49 CFR, Parts 171 - 179: Department of Transportation (DOT)
   m. Federal Standard 313A: Material Safety Data Sheets, Preparation and Submission

2. American National Standards Institute (ANSI)

   a. Z288.2: Standard for Respiratory Protection

3. American Society for Testing and Materials (ASTM)

a. E 849-82: Safety and Health Requirements Relating to Occupational Exposure to Asbestos

4. State and Local Regulations: The Contractor shall comply with all current

a. State of Maryland and Montgomery County Regulations.
b. Title 26, Code of Maryland Regulation (COMAR)
c. Washington Suburban Sanitary Commission (WSSC) discharge standards

5. NIH Policies and Procedures

a. NIH Manual Issuance: 3032 Waste Management at NIH
b. NIH Waste Calendar.

B. Acquisition of Publications: Referenced CFR publications may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

1.4 DEFINITIONS

A. "NIH Controlled Material" is defined as any material that poses a threat to human health or to the environment; that can be recycled or reused; for which disposal in municipal landfills is regulated or restricted; for which unregulated introduction into groundwater, land, or the atmosphere is irresponsible; and that should be designated as "hazardous waste."

1. It is imperative that the use, handling, storage, transporting and disposal of hazardous and recyclable materials and solid waste in NIH facilities and on NIH property be disciplined and consistent -- to both ensure the safety of NIH personnel and visitors and to avoid incurring liabilities or penalties to the NIH as a consequence of reckless or improper disposal or recycling of waste generated in, deposited on, brought to, or transported from NIH facilities.
2. A number of statutes and regulations define the term "hazardous" in a variety of ways depending on the nature, condition, and intended use or disposal of the particular material, substance, and chemical. To simplify the manner in which these materials are addressed, the term "hazardous material" is used to identify all materials, substances, and chemicals that exhibit the properties defined by this specification:

a. Any material, substance, and chemical that because of its quantity, concentration, or physical, chemical or infectious characteristics is toxic, lethal, corrosive, flammable or combustible, reactive, an irritant, a strong sensitizer, or generates pressure by decomposition, heat or other means and is injurious to human beings, animal life and/or the environment shall be considered "hazardous."
b. Exhaustive but not inclusive lists of these hazardous materials are detailed in the following regulations: RCRA 40 CFR 261; CERCLA 40 CFR 302; SARA 40 CFR 355, 370 & 372; FIFRA 40 CFR 152; TSCA 40 CFR 700-799; COMAR Title 26.13.02.15.19.

B. A "recyclable material" is defined as any material that must be recycled or reused under federal, state, or local regulations, or can be recycled and reused in an economically feasible manner.

## 1.5 NIH CONTROLLED MATERIAL STANDARDS AND CONTRACTUAL RESPONSIBILITIES

A. Hazardous materials defined by paragraph 1.4 may not be dumped into storm drains, sewage lines, or dumpsters, nor are they to be introduced into the environment in an uncontrolled manner.

B. Regulatory Compliance: The Contractor shall comply with all federal, state, and local regulations and the conditions of NIH facility operating permits and licenses applicable to activities and services performed under the contract. A partial but not an inclusive list of such laws and regulations are identified in paragraph 1.3 of this specification.

C. All contractors will be informed of hazardous materials and potential hazards present in the areas in which the contractor's employees will be working.

D. Upon request by the Contracting Officer, the Contractor shall provide documentation that personnel are properly trained in generating, handling and storing hazardous wastes.

E. Contractors shall become familiar with and abide by the requirements of the DES Standard for the Use, Handling, Storage, Transporting, and Disposal of Hazardous Materials. Consult with the NIH Division of Safety, Environmental Protection Branch as required or if so directed by the Project Officer.

F. The Contractor shall dispose of hazardous materials belonging to him or which is generated as a result of this contract, at no additional expense to the NIH. Waste shall be disposed of on a daily basis.

G. Hazardous wastes belonging to the NIH will be disposed of by the NIH. The Contractor shall notify the Contracting Officer when NIH-owned hazardous wastes are discovered and/or become necessary to be removed from the project site.

H. Contractor Liability and Responsibility

1. The Contractor shall assume full responsibility and liability for compliance with all applicable regulations affecting the health and safety of Contractor personnel and others at the NIH during work operations.
2. In the performance of the contract, the Contractor shall provide for the protection of the health and safety of NIH employees, guest workers, and the public who may be located in areas contiguous, adjacent, or near the work site, and prevent damage to NIH property, materials, supplies, and equipment.
3. The Contractor shall assume full liability and responsibility for all hazardous materials brought to the contract site. The use, handling, storage, transporting and disposal of such materials shall comply with all regulatory conditions, the manufacturer's recommendations, and the Material Safety Data Sheet (MSDS) for that substance. Copies of the MSDS's will be maintained on-site. Quantities of materials stored and used at the work site shall be limited to the minimum amount required to accomplish the prescribed task or activity.
4. NIH operates as a treatment, storage and disposal facility as well as an owner and generator. The Contractor will be responsible for site storage, shipment and disposal of

hazardous wastes and substances. The Contractor will be responsible for proper shipment and disposal at Contractor-proposed, NIH-approved disposal facilities.

I. Provisions for and Conditions of Temporary Storage of Hazardous Materials on NIH Property: Hazardous waste for which the Contractor is responsible for transportation and disposal may be accumulated at NIH facilities for up to 30 days, except for extremely hazardous waste materials, provided that:

1. The containers holding the hazardous waste are in good condition, are labeled with all contents, and are not leaking.
2. The containers are made of or lined with materials that will not react with, and are otherwise compatible with, the hazardous waste to be stored, so that the ability of the container to contain the waste is not impaired.
3. The containers are closed during storage, except when it is necessary to add or remove waste, and the containers are not opened, handled, or stored in a manner which may rupture the container or cause it to leak.
4. The containers are inspected at least weekly, to check for leaks and for deterioration caused by corrosion or other factors.
5. The containers are securely stored away from high traffic areas in a locked area to prevent deliberate or accidental release of hazardous materials.
6. The location selected for storage of the waste containers provides secondary containment of accidental discharge from the containers.
7. The containers are stored at a location on the job-site pre-approved by the Contracting Officer.
8. If a container is leaking, the waste must be immediately transferred to a sound container by the Contractor and treated as a hazardous material spill.

J. Disposal Method

1. The Contractor shall maximize the use of treatment facilities that employ valid, best available technologies to permanently destroy or render the hazardous material nonhazardous.
2. Land disposal of hazardous waste shall be minimized. Landfills shall only be employed by the Contractor when no other satisfactory method of treatment for a particular waste is available.
3. Recycling and reuse of materials are encouraged to the extent economically feasible.

K. Hazardous Material Spill: Hazardous material spills on-campus shall be reported immediately to the NIH Fire Department (Dial 911), or if off-campus and the telephone is on the NIH exchange, dial 9-911. The Contractor shall take immediate measures to contain the spill, prevent its spread, and ensure proper cleanup. If there is a threat to health or safety, or danger of further contamination, NIH may elect to take charge of the cleanup, perform the required cleanup, and charge the Contractor for expenses incurred. Hazardous material spill response is explained in paragraph 1.8.

L. Hazardous Materials Log: The Contractor shall maintain a hazardous materials log on the job site that identifies the type and amounts of materials generated on the site, type and amounts of materials brought to the site and the type and amounts of materials transported from the site. Documentation shall be in chronological order to identify the sequence of activities.

M. The contractor shall maintain an Material Safety Data Sheet (MSDS) binder on the construction site that shall include all hazardous materials used on the construction site and shall be clearly identified and easily accessible to the NIH Fire Department and Safety and Health Branch during and after work hours. The NIH Fire Department shall be notified in writing , through the Project Officer, of the binder location.

N. Alternative Materials: Alternative products and materials that are less hazardous and will produce comparable results must be used.

## 1.6 DELEGATION OF AUTHORITY FOR NIH APPROVAL

A. For work related to NIH Controlled Material, including use, handling, storage, transporting, accumulation and disposal, the Contracting Officer may designate a representative of the Division of Safety, hereinafter referred to as the NIH EPB Compliance Officer, to act in his behalf in hazardous waste issues only. Such delegation of approval authority shall be presented to the Contractor in writing prior to the beginning of efforts by the Contractor in those elements of the contract that relate directly to the work either requiring the use, handling, storage, transporting, accumulation or disposal of NIH Controlled Material.

## 1.7 SUBMITTALS

A. Hazardous Materials Waste Management Plan: Any hazardous materials (i.e. solvents, floor mastic strippers, adhesives, etc.) brought onto the job site by the Contractor or generated as a result of project work shall require the Contractor to prepare a Hazardous Materials Waste Management Plan. This plan shall be prepared and submitted to the Contracting Officer and will be subject to review by the Division of Safety (DS), Occupational Health and Safety Branch (OSHB) and Environmental Protection Branch (EPB). No work shall begin until the plan has been approved by the Contracting Officer, OSHB, and the EPB Compliance Officer. The Hazardous Materials Waste Management Plan shall:

1. Include a list of all hazardous materials to be used on the job site, including how the materials will be used, handled, stored, packaged, manifested, transported and disposed.
2. Ensure that any chemical agents, such as floor-mastic strippers, sealants, adhesives, methylene chloride, or other agents containing strong solvents which might create odor problems, headaches, or other physiological symptoms among NIH or Contractor personnel, will be cleared for use through the Occupational Safety and Health Branch (OSHB), Division of Safety (496-2346).
3. Include the Material Safety Data Sheets (MSDS) for all hazardous materials to be used or generated as a result of the project. This requirement shall be coordinated with Section H of the Contract.
4. Delineate the process, procedures, and methods to be used by the Contractor to contain or evacuate fumes, vapors, dusts, aerosols, etc. that may be released or generated so as to protect NIH personnel when hazardous materials are used or generated.
5. Delineate the safety procedures, personnel protection measures, and precautions to be taken covering all operations involving hazardous materials, including handling, use, loading, transporting, and first aid.
6. Include a hazardous materials spill control plan for work on federal facilities.
7. Include a hazardous materials spill control plan for materials in transit.

8. Include the identification of the State/EPA permit number and Certification of Insurance of any proposed transporter.
9. Include the identification, description, location, and the State/EPA permit number of any proposed disposal site(s).
10. Include the plan to supply and post OSHA Form 20, Safety Data Sheets, during the use of all solvents, liquids, fluids, and substances brought onto Government property.
11. Include a list of all contract employees assigned to the project along with their titles, duties, education, training, and experience.
12. Include a scheme for minimization of the waste volume to the maximum extent possible either through recycling, alternate methods or processes, or conservation of waste materials.

B. Hazardous Waste Manifest

1. The Contractor is responsible for all Hazardous Waste Manifest documentation to include properly filling out the required documentation, maintaining the records, tracking the manifest, and distribution. The Hazardous Waste Manifest will be approved and signed by the EPB Environmental Compliance Officer.
2. The Contractor shall provide the Hazardous Waste Manifest and any other required regulatory shipment documents to the Contracting Officer for review and approval at least one day preceding a planned shipment of hazardous materials or waste. When the manifest is approved and signed by the Contracting Officer, the Contractor shall leave a copy with the Contracting Officer and ensure that appropriate copies accompany the shipment.
3. While the Contractor may arrange off-site transportation activities at his convenience, the Contracting Officer will be available for signing manifests only during normal business hours. The Contractor's transporter shall sign the manifest and provide copies of all documents required for shipment to the Project Officer prior to commencement of shipment.
4. The receiving or disposal facility official shall sign the manifest certifying receipt of the shipment and forward a copy from that facility to the Project Officer within seven (7) days after receipt. The Project Officer shall receive this return manifest within ten (10) days of the shipping order.

C. Approval of Transporter

1. All transporters the Contractor proposes to use must be approved by the Contracting Officer in writing prior to the generation, storage, or removal of hazardous waste materials on the job site. The Contractor shall furnish the Project Officer with a compliance summary of the proposed transporter which minimally contains the following:

    a. Current copies of the transporter's operating permits and licenses.
    b. Copies of environmental impairment insurance.

2. Should there be a need for an alternate transporter in the case of an accident or release in transit, the alternate transporter must be approved by the Contracting Officer.
3. If remedial action is required to contain and cleanup a spill, the Contractor shall work under the direction of the local regulatory authorities responding to the incident. The Contractor shall utilize the most efficient resources available to expedite the control and

cleanup. If such an event should occur in transit, the Contractor shall immediately notify the Project Officer.

D. Approval of Treatment, Storage and Disposal Facilities (TSDF)

1. All transfer facilities or treatment, storage and disposal facilities the Contractor proposes to use must be approved in writing by the Contracting Officer prior to removal, generation, or storage of hazardous materials on the job site.
2. NIH reserves the right to prohibit the Contractor from employing the services of a subcontractor that does not possess the ability to satisfactorily perform in conformance with the provisions of the contract. The use of a subcontractor(s) does not relieve the Contractor of any requirements or responsibilities set forth in the contract. The Contractor is responsible to ensure that any subcontractor(s) perform in accordance with the terms and conditions of the contract.
3. If, during the period of the contract, the Contractor requests the approval of additional TSDFs, NIH must be allowed reasonable time to evaluate such requests.

E. PCB Plan of Action: Provide a PCB Plan of Action in the Hazardous Materials Waste Management Plan for approval by the Contracting Officer addressing all requirements set forth in paragraph 3.3.D of this section, including the location of EPA approved recycling and incineration sites, qualifications of transporter, methods and transport, and a description of the methods to be employed to prevent release to the environment. The Contractor shall explain the method for documenting proper PCB disposal (incineration) to the Contracting Officer and include the written procedures in the Hazardous Materials Waste Management Plan.

F. Certification of Final Disposition

1. It is the Contractor's responsibility to obtain all necessary documentation to prove the final treatment/disposal of all wastes has been accomplished. This documentation shall be included in the Certificate of Final Disposition and submitted with, or prior to, the invoice for payment. A Certificate of Final Disposition shall itemize each container received at the treatment/disposal facility by its NIH Transportation Container number, shall document the date and method of treatment or disposal, and shall be forwarded to the Contracting Officer within four (4) months of the date the material was received at the disposal facility.
2. If the material is disposed of in a secured chemical landfill facility, then the Certificate of Final Disposition shall also indicate the location within the landfill where the waste container was buried through the use of cell numbers, coordinates, or other appropriate identifiers.

## 1.8 EMERGENCY RESPONSE AND REMEDIATION OF SPILLS AND RELEASES

A. Notify Contracting Officer: The Contractor shall be responsible, in the event of a spill of hazardous material resulting from the execution of this contract, to immediately notify the Project Officer. The following information will be supplied to the Contracting Officer in writing as part of the notification process:

1. Type of material.
2. Quantity of material spilled.

3. Date and time spill occurred.
4. Environmental media released; i.e., air, water, soil, etc..
5. Location, type and extent of spill.
6. Cause of spill.
7. Methods used or proposed to control or cleanup the spill.

B. Spill Kits: The Contractor is responsible for providing spill kits at the work site for all hazardous materials brought into the workspace by the contractor.

C. Reporting of Spills, Leaks and Releases: The Contractor is not authorized to issue press releases concerning incidents on NIH installations or to report releases on or from NIH installations to regulatory authorities. Such news releases and reporting shall be performed only by NIH personnel designated by the Contracting Officer.

D. Compliance with Contingency and Spill Prevention Control and Countermeasure Plans and Participation Drills: In compliance with Title 40 CFR, some NIH installations have internal Contingency and Spill Prevention Control and Countermeasure plans. Upon award of this contract, the Contractor shall ensure that all on-site contractor personnel are thoroughly familiar with these plans and comply with them as they apply to contract operations.

## 1.9 PERSONNEL QUALIFICATIONS AND REQUIREMENTS

A. The Contractor must ensure that every person is trained pursuant to the directions in 49 CFR 172.202 and HM-126F if they are responsible for any of the following:

1. Prepares hazardous materials for use, storage or disposal.
2. Handles, loads, unloads or moves hazardous materials.
3. Fills out forms for the transportation of hazardous materials.
4. Is in any way responsible or accountable for any hazardous materials in NIH facilities.

B. Qualified personnel are essential and shall be provided by the Contractor for the performance of this contract to assure that public health, safety, and protection of the environment are assured during the use, handling, packaging, transporting, treatment and/or disposal of hazardous materials and that property of the NIH is protected.

C. Contractor personnel must possess all personal licenses, permits, and certifications required to perform their duties. For example, truck drivers hauling hazardous wastes in Maryland must hold current CHS Driver Certifications.

D. The Contractor's personnel shall perform in a professional and courteous manner and shall abide by applicable NIH rules, regulations and procedures; and shall present a neat appearance when working at NIH facilities. The Contractor personnel shall not wear protective equipment or clothing when in lunch rooms, cafeterias, and other public areas where such protective items are unnecessary.

1.10 ENVIRONMENTAL SAFETY OFFICER

A. The Contractor shall retain the <**full time**><**part time**> services of an Industrial Hygienist certified by the American Board of Industrial Hygiene (ABIH), and possessing previous experience in hazardous materials work. The Industrial Hygienist shall interpret the published rules and regulations governing hazardous materials and will provide direction in the implementation of said regulations and safety requirements. This work shall include but not be limited to:

1. Monitoring the Contractor's work with hazardous material for compliance with published rules and regulations by EPA, OSHA, and the State of Maryland including use, handling, storage, packaging, transporting and disposal.
2. Monitoring the generation of hazardous vapors, fumes, dusts, aerosols, etc.
3. Providing the Project Officer with all required documentation pertaining to hazardous materials use, handling, removal, cleanup, transport, and disposal.
4. The Industrial Hygienist is required to be present on site for the following activities/phases of this project. The contractor may elect to employ the Industrial Hygienist for additional times as required in the Contractor's Safety and Health Program as necessary to meet established regulations.

    a. <**Activity**>

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment, including disposable protective clothing, used in the execution of this contract and/or provided to visitors to the site, shall comply with applicable Federal, State, and local regulations.

2.2 TOOLS

A. Tools used in the execution of this contract and/or provided to visitors to the site, shall comply with applicable Federal, State, and local regulations. Tools shall be used in strict compliance with manufacturers written instructions for their intended use.

2.3 MATERIALS

A. Materials used in the execution of this contract and/or provided to visitors to the site, shall comply with applicable Federal, State, and local regulations. Materials shall be used in strict compliance with manufacturers written instructions for their intended use.

B. Product Material Safety Data Sheets (MSDS): MSDS's will be submitted as part of the Contractor's Hazardous Materials Waste Management Plan and maintained on-site along with all product data from the manufacturer for all applicable substances to be used. All products must comply with NIH Fire Safety Requirements.

C. Container requirements: All transportation containers purchased and used by the Contractor shall meet DOT Title 49 CFR requirements and regulations for shipment of hazardous materials. Only new containers, free from damage which could compromise the integrity of the container, shall be used. Any damaged containers shall be rejected by the Project Officer and replaced by the Contractor at no cost to NIH. The Contractor shall provide all documents and container labels as required.

D. All Product Data and corresponding manufacturers information, shop drawings and manuals must be submitted and approved prior to initiation of work. All product data must be maintained on site at all times during work.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Isolate the Hazardous Material area for the duration of the work to prevent unauthorized access by designating the area off limits to all but authorized personnel. Maintain a log of all persons visiting the Hazardous Material work site.

B. Post warning signs and labels as required by this contract, 29 CFR 1910, 40 CFR 761, and as directed by the Contracting Officer.

### 3.2 WORK PROCEDURES

A. General Procedures: Perform all Hazardous Materials related work in strict compliance with the general safety and health provisions of the referenced requirements. If a conflict arises in the regulations, the more stringent application/requirements for overall safety shall apply until a determination is made otherwise by the Contracting Officer.

B. Coordination of Work of all Trades: Coordinate the work of all trades to assure their work is performed in accordance with the applicable regulations and the hazardous materials control area remains separated from the remaining work areas.

C. All contractors will be informed of hazardous materials and potential hazards present in the areas in which the contractor's employees will be working.

### 3.3 REQUIREMENTS FOR SELECTED NIH CONTROLLED MATERIALS

A. Lead

1. SPECIAL PERMITS REQUIRED: The State of Maryland requires that lead abatement and lead removal be done only by those with a specific license. Verification of a current license will be submitted to the Contracting Officer.
2. ITEMS USUALLY CONTAINING LEAD: paint, soft solder, radiation shielding, pipe, terne roofing.

3. OPERATIONS INVOLVED: chipping, sanding, grinding, soldering, welding, flame torch cutting abrasive blasting, and spray painting.
4. DEMOLITION PROCEDURES: Demolition procedures shall meet OSHA Guidelines "Working with lead in the construction industry," OSHA Publication 3126, latest edition. This standard lists hazard-reducing techniques for lead demolition such as using vacuum dust collection systems to capture lead dust and fumes at the point of generation. Paint removal shall not employ an open flame, or dry sanding or grinding. Also, the use and selection of respiratory protection and other protective equipment shall be as specified.
5. RECYCLING: Large quantities of lead such as lead sheeting and lead blocks must be recycled.
6. DISPOSAL: Disposal of lead shall be in accordance with paragraph 1.5.

B. Mercury

1. ITEMS CONTAINING MERCURY: manometers, thermometers, pumps, switches, relays, thermostats, fluorescent tubes.
2. REMOVAL: Segregate all materials containing mercury and prevent mercury from being combined with other liquid or solid hazardous or nonhazardous materials.
3. STORAGE: Mercury and mercury-containing materials shall be stored in appropriate containers that are clearly labeled to identify the contents. Appropriate containers are those that will not deteriorate or react with mercury or allow mercury to leak into the environment during normal use handling, and disposal procedures. Regulations for containing and labeling mercury and mercury-containing materials can be found in 49 CR 172.101.
4. DISPOSAL: Disposal of mercury shall be in accordance with paragraph 1.5.

C. Batteries: Batteries are not to be discarded in waste dumpsters that are sent to the Montgomery County Solid Waste Transfer Station.

1. USES OF BATTERIES: Emergency lightning, uninterruptible power supplies (UPS), emergency power generation.
2. DISPOSAL: All batteries, regardless of size or material, are to be properly disposed of or recycled by the Contractor in accordance with paragraph 1.5.

D. Items with Liquid Dielectric Suspected of Containing PCBs (Polychlorinated BiPhenyls)

1. TYPES OF ITEMS: Fluorescent light fixture ballasts, oil circuit breakers, capacitors, liquid transformers, electrical ballasts. Items manufactured after 1978, should carry a label "NO PCBs". Items not clearly labeled, or without labels, or having unknown dielectric shall be considered to contain PCBs under this specification and shall be treated, handled and disposed as hazardous PCB waste.
2. REMOVAL: The following is a basic outline of the minimum steps that shall be taken during the removal of PCB containing ballasts from buildings. The plan of action shall be submitted by the Contractor for approval by the Contracting Officer, shall include the procedures he intends to follow and shall address these points:

    a. A minimum of two layers of 6-mil plastic shall be placed on the floor beneath the disposal drums, the actual work area, and beneath stored disposal drums.
    b. Pour a minimum three inch layer of oil absorbent in a DOT 17-H drum labeled as containing PCB.

c. Remove the light ballast from the light fixture. Wires exiting from the ballast shall be cut to less than three (3) inches long. Place the ballast in the drum. If the ballast is clearly labeled as "Non-PCB" or "No PCB", then the ballast can remain with the fixture and the fixture can be removed and disposed in accordance with standard procedures established in the contract for demolition debris.
d. If an unmarked ballast shows any sign of leaking, PCB resistant gloves shall be worn when handling the fixture. If the PCB status cannot be clearly determined from the label, the ballast shall be removed from the fixture and treated as hazardous waste.
e. Dispose of any light fixture which held an unlabeled leaking ballast as PCB contaminated material.
f. Alternately layer the ballasts and 2-inch layers of absorbent until the drum is full, carefully checking to assure that the last layer in the drum will be absorbent.
g. Place all used disposable protective clothing and plastic in the drum.
h. Label the drum with a DOT-OREM label with the following minimum information:

1) Date materials were placed in the drum.
2) Materials in the drum, i.e. "75 two-tube light ballasts.
3) Name, address and phone number of the manufacturer of the generator, or owner of the light ballasts.
4) Container identification number (ex; DC0093ZZ-001BAL)
5) The weight of each container is to be recorded (in kilograms) and entered on the manifest.

i. Make arrangements, i.e. obtain EPA Generator Identification Number, make EPA notifications, fill out hazardous waste manifest, and incinerate or recycle the material in the drum(s) as PCB contaminated solid waste.
j. Transport the drum(s) and any other PCB materials to an EPA approved incinerator or ballast recycling facility.
k. The Contractor may transport the drum(s) and other PCB materials to an EPA approved ballast recycling facility which dismantles the ballast, segregates, and packages the PCB components of a ballast for incineration and then reclaims non-contaminated materials remaining after recycling are to be destroyed by incineration.

3. STORAGE: Short term storage shall be in accordance with paragraph 1.5 herein.
4. DISPOSAL: Immediately arrange for disposal of these items. Collect and dispose of all other PCB contaminated waste, rags, scrap, debris, bags, containers, equipment, and PCB-contaminated clothing in properly labeled PCB disposal drums. Waste PCB containing material shall be transported to an incineration site or ballast recycling facility. Incinerate all PCB-contaminated materials remaining after recycling. The Contractor shall provide the Project Officer with a copy of all manifests and continuation sheets resulting from the incineration of the PCB-containing waste. In some instances, a temporary holding area can be established upon approval by the Contracting Officer for properly packaged PCB waste.
5. EMERGENCIES: Should the Contractor find a ballast that is leaking, the NIH Fire Department shall be called immediately (dial 911 on the main NIH campus) to assess the danger and to decontaminate any areas that may have been contaminated by the leakage.

E. Oils - Confirmed NON-PCB Containing

1. ITEMS CONTAINING OILS: Internal combustion engines, bearings, refrigeration and heating units, all industrial machinery. Waste oil may also be in oily rags used for maintenance and possibly in soil contaminated by leaks or spills.
2. RECYCLING: The Contractor shall make every effort to recycle the waste oil. If there is an economically feasible method to recycle the waste oil, the Contractor shall do so. This is required under the provisions of Executive Order 12780, dated October 31, 1991.
3. STORAGE: The Contractor shall not mix waste oils with general waste. Waste oils shall be stored in appropriate containers that are clearly labeled to identify contents. Appropriate containers are those that will not deteriorate or react with the oil or allow the oil to leak into the environment during normal use, handling, and disposal procedures. Regulations for containing and labeling petroleum oil waste can be found in 49 CFR 172.101.
4. DISPOSAL: All material are to be properly disposed of or recycled by the Contractor in accordance with paragraph 1.5 herein.

F. Solvents. The Contractor shall use non-toxic and non-flammable solvents whenever these alternative solvents are feasible.

1. KINDS OF SOLVENTS: Paint solvents, gasoline, and other toxic and ignitable solvents.
2. STORAGE: The Contractor shall not mix solvents with general waste. Solvents shall be stored in NFPA-approved flammable liquid containers that are clearly labeled to identify contents. Appropriate containers are those that will not deteriorate or react with the solvents or allow the solvents to leak into the environment during normal use, handling, and disposal procedures. Regulations for containing and labeling solvents can be found in 49 CFR 172.101.
3. DISPOSAL: All materials are to be properly disposed of by the Contractor in accordance with paragraph 1.5.

G. Chlorofluorocarbons (CFCs)

1. USES OF CHLOROFLUOROCARBONS: Refrigerants, propellants in some aerosol cans.
2. FEDERAL REGULATIONS FOR CFCs: As of July 1, 1992, the Clean Air Act makes it unlawful to vent CFCs to the atmosphere. During the repair, serving, or replacement of items such as cold rooms and chillers, CFCs shall be captured before they would otherwise be released to the atmosphere. When refrigerant systems are to be purged of air, venting of CFCs must be kept to a minimum.
3. STORAGE: The Contractor shall store used refrigerant in containers meeting DOT regulations for refill services. Drums and other storage containers shall be checked for leaks prior to use. When known, these containers must be labeled with the specific CFC they contain.
4. DISPOSAL OF AEROSOL CANS:

    a. Aerosol cans that are empty in accordance with 40 CFR 261.7 provisions may be disposed of as conventional waste.
    b. Aerosol cans that are not empty in accordance with 40 CFR 261.7 shall be considered hazardous material and shall be disposed of in conformance with hazardous material regulations.

c. Aerosol cans having an unknown propellant shall be considered to contain CFCs under this specification and shall be treated as such.
d. Disposal shall be in accordance with paragraph 1.4
e. CFC CAPTURE: CFCs will be captured for reuse or recycling.

H. Gas Cylinders

1. KINDS OF GAS CYLINDERS: All compressed gases.
2. INSPECTION: Gas cylinders shall be visually checked for damage and shall be handled and moved in a manner than will not damage the valves or rupture the cylinders.
3. DISPOSAL: Gas cylinders shall be returned to the gas vendor either for refilling or proper disposal depending on the condition of the cylinder. In no case shall the Contractor discard these cylinders in waste dumpsters.

I. Scrap metal and containers (contaminated)

1. KINDS OF HAZARDOUS SCRAP METAL: Metal as well as plastic drums and containers that once held NIH regulated waste (including solvents, oils, paint); cadmium; duct systems that contain residue of hazardous materials, etc.
2. STORAGE: Spent metal or plastic drums and containers over 5-gallon capacity shall not be included with general waste. These items shall be stored and disposed of separately. The containers shall be clearly labeled to identify they are empty but also the label shall clearly identify the original contents to facilitate disposal. Other hazardous scrap metal shall be stored in containers that will not react with the material or allow the hazardous material to disperse into the environment.
3. DISPOSAL: All materials are to be properly disposed of by the Contractor in accordance with paragraph 1.5.

J. Scrap Metal (non-contaminated).

1. SOURCES OF NON-HAZARDOUS SCRAP METAL: Lab casework, metal wall partitions, sheet metal, nuts, bolts, and other metal construction waste.
2. RECYCLING: Every attempt shall be made to recycle these materials by the Contractor to conform with Executive Order 12780 dated October 31, 1991.
3. DISPOSAL: If material cannot be recycled, non-hazardous scrap metal shall be disposed of as construction debris in accordance with the contract.

K. Paint: The Contractor shall use non-toxic and non-flammable paints whenever these alternative paints are feasible. Use of lead containing paint is prohibited. For removal or disposal of lead-containing paint, see paragraph 3.3.A.

1. KINDS OF PAINTS: Toxic and/or flammable oil based paint.
2. STORAGE: The Contractor shall not mix hazardous paints with general waste. Toxic and/or flammable paints shall be stored in NFPA-approved flammable liquid containers/cabinets that are clearly labeled to identify contents. Appropriate containers are those that will not deteriorate or react with the paints or allow the paints to leak into the environment during normal use, handling, and disposal procedures. Regulations for containing and labeling paints/solvents can be found in 49 CFR 172.101. All paint containers shall be sealed securely to prevent spilling or dispersal during transport.

3. DISPOSAL: All materials are to be properly disposed of by the Contractor in accordance with paragraph 1.5.

## 3.4 PACKAGING, LABELING, AND MARKING OF HAZARDOUS WASTE MATERIALS FOR SHIPMENT OFF-SITE

A. General Shipping Requirements: Contractor shipments of hazardous and mixed wastes or materials shall be performed in accordance with the latest revision of all applicable EPA Title 40 CFR, NRC Title 10 CFR, and DOT Title 49 CFR requirements. As new packaging, labeling, and shipping regulations are promulgated and approved, the Contractor shall take the necessary measures to comply. The Contractor shall provide all documents and labels required for shipping wastes and materials.

## 3.5 SHIPPING TO TREATMENT, STORAGE, AND DISPOSAL FACILITIES AND OTHER OFF-SITE DESTINATIONS.

A. Use of Hazardous Waste Manifest: Uniform Hazardous Waste Manifests (EPA Form 8700-22 or latest revision thereof) shall be properly completed by the Contractor for each waste shipment and shall list each transportation container including any non-hazardous waste or hazardous materials shipped. The Contractor shall use the manifest of the receiving state unless that state does not have one, in which case the Contractor shall use the generator state manifest. All manifest information shall be neatly typed and contain all information required by applicable federal, state, and local hazardous waste or materials regulations. The Contractor shall provide all data required for waste transportation, treatment, or disposal, and for completion of hazardous waste or material generator report as required by the regulatory agency of jurisdiction.

B. DOT Emergency Response Information Requirements: The Contractor and the transporter must comply with the DOT Emergency Response Communication Standards applicable to the shipment of hazardous materials.

C. Use of Permitted Hazardous Waste Facilities with Full RCRA Permit Status.

1. Storage, treatment or disposal of hazardous wastes and materials shall be carried out only at facilities that have been issued final operating permits pursuant to RCRA and implemented by the hazardous waste regulatory authority(ies) of jurisdiction. Facilities that have applied for formal permits, and are in interim status, may be used by the Contractor only upon written certification by the Contractor that no fully permitted facilities are available and upon written approval of the interim status facility by the Contracting Officer. All Facility Permits must explicitly state that they are permitted for each particular waste and material that is to be treated, stored, or disposed of under this contract.
2. All facilities used for interim treatment or final treatment and disposal of items under this contract shall have as a minimum an EPA and state approved interim status permit showing EPA hazardous waste numbers for each waste the facility is permitted to handle, as described in 40 CFR 261, Subparts C and D. Mere acceptance of the waste or material at a properly permitted TSDF does not meet the definition of final treatment and disposal under this contract.

## 3.6 FIELD QUALITY CONTROL

A. Site Inspection and Stop Work Orders: While performing this work, the Contractor shall be subject to on-site inspection by NIH officials or NIH contracted inspection services. Work shall also be subject to inspection by OSHA and EPA inspectors and/or local building or health officials. If found to be in violation by any of these officials, the Contractor shall cease all work immediately. Until the violation is resolved, standby time required to resolve the violation shall be at the Contractor's expense.

## 3.7 CLEANUP AND DISPOSAL

A. Permits and Notifications: Secure necessary permits in conjunction with hazardous material removal, hauling and disposition and provide timely notification of such actions, as may be required by federal, state, regional and local authorities. Notify the Regional Office of the United States Environmental Protection Agency and provide copies of the notification to the Contracting Officer 10 calendar days prior to the commencement of the work.

B. Housekeeping: Essential elements of Hazardous Materials control include housekeeping and cleanup procedures. Maintain all surfaces within the work area free of accumulations of debris to prevent further dispersion and contamination. Given meticulous attention to restricting the spread of debris, keep waste from being distributed over the general area or to other areas in the building. The blowing down of the work area with compressed air is forbidden. Post appropriate hazard warning signs. In all possible instances workmen shall cleanup their own areas. Equip personnel engaged in cleaning up scrap and waste with appropriate personal protective clothing.

C. Approval of Final Cleanup: The Contracting Officer will inspect the work area in concert with the NIH industrial hygienist for approval of the Hazardous Material cleanup. Visual observation of potential contamination, dust or debris is not permitted on any surface in or around the work area. The Contracting Officer will approve final cleaning and restoration of the work area.

END OF SECTION 01548

# SECTION 015950 - SAFETY AND HEALTH

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Inclusive Nature of the Requirements of this Section: All Work performed under this contract is subject to the requirements of this Section.

B. Safety and Health Program:

1. The Contractor shall develop and implement an effective safety and health program in accordance with Occupational Safety and Health Administration (OSHA) Regulations and the US Army Corps of Engineers Manual 385-1-1 (EM 385-1-1).
    a. EM-385-1-1 Waiver: The Contractor may request a waiver from the EM 385-1-1 requirements prior to commencing work activities. The following process shall be used when requesting a waiver or a variance:
        1) Specify the exact requirement from which relief is being sought, providing the exact citation and quoting the requirement in question. A separate request must be made for each requirement;
        2) Provide statement as to whether a waiver (total elimination of the requirement) or a variance (retaining the basic requirement, but doing it differently) is being sought;
        3) Provide details as to why it is not possible or practical to comply with the requirement;
        4) Explain method the Contractor suggests to use in lieu of the existing requirement and how it provides protection equal to or greater than the requirement under waiver review. The burden of proof rests with the requesting Contractor.
2. Each contract employee is responsible for complying with applicable safety and occupational health requirements, wearing prescribed safety and health equipment, reporting unsafe conditions/activities, and avoid actions and conditions that may result in an accident.
3. The Contractor will not begin work authorized under this contract, except for authorized preliminary activities (i.e. mobilization), without first submitting for review a Site Specific Accident Prevention Plan to the NIH Project Officer and ORF Safety Officer (safety@nih.gov) that meets the requirements of EM 385-1-1.

C. Contractor's Responsibility:

1. The Contractor assumes full and sole responsibility for and shall comply with all laws, regulations ordinances, and governmental orders pertaining to employee worksite safety

in the performance of this Contract. The Contractor shall be responsible for employing appropriate safety measures and taking all other actions reasonably necessary to protect the life, health, and safety of the public and to protect adjacent and NIH-owned property in connection with the performance of the scope of work.

2. The Contractor shall be solely and completely responsible for the safety of all workers, NIH employees, public and NIH property in performance of the scope of work. This requirement shall apply at all times while work is being performed under this contract, and is not limited to only normal working hours. Nothing the NIH may do, or fail to do, with respect to safety in the performance of the scope of work shall relieve Contractor of this responsibility.

D. General Contractor Obligations:

1. The Contractor is responsible for accident prevention and worksite safety. This responsibility cannot be delegated to Subcontractors, suppliers, the NIH, or other persons. To this end, the Contractor shall:
   a. Promote a safe and healthy work environment.
   b. Provide a Site-Specific Accident Prevention Program.
   c. Ensure employees are adequately trained in occupational safety and health topics relevant to the activities to be performed under this contract. Maintain documentation of the employee training, to include the date and subject taught.
   d. Instruct all employees of safe work methods and practices when assigning work.
   e. Ensure that employees have and use the proper protective equipment and tools for the job.
   f. Ensure that all heavy equipment operators (i.e. cranes, loaders and forklifts) are properly qualified and trained on the specific piece of equipment in use.
   g. Plan and execute all work to comply with the stated objectives and safety requirements contained in the contract provisions, Federal, State, local laws and regulations, and industry standards.
   h. Cooperate fully with the NIH, and its Representatives in connection with all matters pertaining to safety.
   i. Conduct an orientation training program for new employees that includes at a minimum, a review of:
      1) Potential hazards in the work areas
      2) Required personal protective equipment and apparel
      3) Methods to mitigate hazards as appropriate
      4) Emergency response relevant to the area

2. Site Inspections:
   a. The Contractor Site Safety and Health Officer shall perform and document daily inspections of the project site, assess and immediately correct any substandard safety conditions or practices, including those of any Subcontractor.
   b. The Contractor shall specifically respond in writing to any substandard safety conditions or practices identified by the NIH.
   c. Daily inspection records shall be maintained at the project site and be made available upon request by the NIH Project Officer or ORF Safety Officer.

3. Safety meetings shall be conducted to review past activities, plan for new or changed operations, review pertinent aspects of appropriate Activity Hazard Analysis, establish safe working procedures for anticipated hazards, and provide pertinent safety and health training and motivation.

a. Meetings shall be conducted at least once a month for all supervisors on the project location and at least once a week for all workers by supervisors or foremen.
b. Meetings shall be documented, including the date, persons in attendance, subjects discussed, and names of individual(s) who conducted the meeting. Documentation shall be maintained and copies furnished to the NIH on request.

4. Injuries and Illnesses:
   a. Ensure prompt medical treatment is administered to any injured or ill employee.
   b. During business hours (7:30 am -5:00 pm, M-F) contractor injuries and illnesses should be treated by the Occupational Medical Service (Building 10, 6th Room 6C306, phone 301-496-4411).
   c. Injuries and illnesses other than first-aid treatment should be administered by third party provider.
   d. In all cases, an injury or illness resulting from work under this contract shall be reported to the Occupational Medical Service, the NIH Project Officer and ORF Safety Officer within 24-hours of the incident
   e. Undertake a complete investigation of all accidents, injuries, illnesses and implement corrective action to prevent a recurrence.

5. Communication of Requirements to Subcontractors and Others: Ensure that all of its Subcontractors, suppliers delivering materials or services to the worksite, etc., are provided with a copy of this specification and are informed of their obligations regarding worksite safety under this requirement.

6. Compliance with Regulations and Applicable Reference Standards: Comply with all applicable OSHA regulations and the US Army Corps of Engineers Manual (EM 385-1-1).

E. NIH Rights

1. Inspections and Investigations:
   a. The NIH Project Officer may, in any reasonable manner, observe and inspect the Contractor's safety and accident prevention procedures for all activities and personnel working at the construction sites, including the Contractor, Subcontractors, visitors, and materials or equipment suppliers. This specifically includes, but it not limited to, the right to attend all safety meetings.
   b. Upon request, the NIH Project Officer shall receive copies of any daily Construction Safety Inspection Reports completed by the Contractor or anyone performing work for, on behalf of or under the Contractor.
   c. The NIH Project Officer shall receive written copies of accident or incident reports completed by the Contractor within 24-hours of occurrence. This report shall include but not be limited to those reports prepared pursuant to OSHA regulations.
   d. The NIH Project Officer may, in any reasonable manner, observe or participate in any accident investigation conducted by the Contractor or anyone performing work for, on behalf of or under the Contractor. The NIH may also, at its sole discretion and in any reasonable manner, undertake its own accident investigation.
2. Corrective Actions / Stop Work
   a. The NIH Project Officer shall have the right to direct the Contractor to correct unsafe working conditions, including taking corrective action when unsafe working conditions are observed (i.e. lack of good housekeeping practices, use of

equipment in obviously poor condition, failure to adhere to statutory OSHA regulations, etc.).

b. The NIH Project Officer shall have the right to require the removal, from the work site, any person, property or equipment that, in the NIH's opinion, is deemed unsafe.

c. The NIH Project Officer shall have the right to instruct the Contractor to immediately cease any action and/or stop work (or any action thereof) when any conditions exist that, in the NIH's opinion, constitutes and imminent danger or could result in serious harm.

d. The NIH Project Officer shall have the right to suspend the work pending the completion of any accident/incident investigation, whether undertaken by Contractor, the NIH or others.

e. The Contractor is responsible for costs, expenses and other obligations paid or incurred, as a result of the Contractor or Subcontractor's noncompliance with Federal, State, or Local safety regulations; or failure to comply with terms and conditions of this contract.

3. NIH Action / Inaction

a. Nothing the NIH may do, or fail to do, with respect to safety in the performance of the work shall relieve the Contractor of its responsibility to comply strictly with this Contract and all standards referenced in this document.

F. References: In addition to publications referenced in the Construction Contract Clauses, the following Code of Federal Regulations (CFR) publications designate and define hazardous materials and conditions, and establish procedures for handling these materials and conditions. Omission of any publication in this section does not remove any obligation or legal requirement on the part of the contractor to comply with all legal requirements for the location of the work.

1. 29 CFR, Part 1910: Occupational Safety and Health Administration (OSHA) General Industry and Health Standards.
2. 29 CFR, Part 1926: OSHA Construction Industry Standards.
3. 40 CFR, Part 61: National Emission Standards for Hazardous Air Pollutants.
4. 40 CFR, Part 261: Environmental Protection Agency (EPA) Characteristics of Hazardous Waste.
5. 40 CFR, Part 761, EPA Polychlorinated Biphenyls (PCBs), Manufacturing, Processing, Distribution in Commerce and Use Prohibitions.
6. 40 CFR, Part 763: EPA Asbestos.
7. Federal Standard 313A: Material Safety Data Sheets, Preparation and the Submission of.
8. NIH DES Instruction 1340-7: Precautions and Procedures for Entering Manholes or Other Below Grade Confined Spaces.
9. NIH DCAB publication "Standards for Temporary Construction," March 1988.
10. U.S. Army Corps of Engineers Safety and Health Requirements Manual, (EM 385-1-1, 11/3/03)
11. National Fire Protection Association (NFPA) publication NFPA 70E
12. National Fire Protection Association (NFPA) publication NFPA 101

G. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to cutting and patching. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

1. Division 01 Section "Summary"

2. Division 01 Section "Project Management and Coordination"
3. Division 01 Section "Construction Progress Documentation"
4. Division 01 Section "Photographic Documentation"
5. Division 01 Section "Submittal Procedures"
6. Division 01 Section "Quality Requirements"
7. Division 01 Section "References"
8. Division 01 Section "Construction Quality Control"
9. Division 01 Section "Temporary Facilities and Controls"
10. Division 01 Section "Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material"
11. Division 01 Section "Safety and Health"
12. Division 01 Section "Product Requirements"
13. Division 01 Section "Execution Requirements"
14. Division 01 Section "Cutting and Patching"
15. Division 01 Section "Selective Demolition"
16. Division 01 Section "Closeout Procedures"
17. Division 01 Section "Demonstration and Training"

H. Hazardous Materials: Some hazardous and toxic materials and substances are included in 29 CFR Part 1910, subparts H and Z, and in 29 CFR Part 1926 and others additionally defined in Federal Standard 313A. Commonly encountered hazardous materials include but are not limited to asbestos, PCBs, explosives and radioactive material.

1. Asbestos may be found in spray-on fireproofing, insulation, boiler lagging, pipe coverings and other materials.
2. PCBs may be contained in transformers, capacitors, voltage regulators, oil switches, mechanical insulation and other materials.

I. Acquisition of Publications: Referenced CFR publications may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

## 1.3 DEFINITIONS

A. ORF Safety Officer: An employee of the NIH, or designated representative who is responsible for the day-to-day management of the ORF Safety Program.

## 1.4 SUBMITTALS

A. General: All submittals required under this Section must be provided to the NIH Project Officer.

1. Copies: Provide copy of the submittals via email to safety@nih.gov.
2. Software: Submittals shall be in either MS Word or Adobe Acrobat.
3. Delays: Delays caused by failure to submit the required documentation shall not be considered a reason for extension of contract time or increase in costs to the Government.

B. Contractor's Safety and Health Program: The contractor shall submit a Site Specific Safety and Health Program which includes a Site Specific Safety and Health Plan and a copy of the

Company Safety and Health Plan to the Contracting Officer within 14 calendar days of the Notice to Proceed or before work commences on the project site, whichever is earlier.

1. NIH will review the submitted Safety and Health Plan for general conformance to the requirements of the Contract Documents.
2. NIH will not make any judgment as to the adequacy of the submitted plans with respect to federal, state, and local safety laws and safety regulations. If the plans are found to meet the requirements of the Contract Documents, NIH will acknowledge that the Contractor has provided copies of the plans and accept them as meeting the contract requirement for the Contractor to provide copies of his safety program.
3. NIH will not approve any contractor Safety and Health Plan. Safety is the Contractor's responsibility under the current laws and governing regulation.
4. NIH's review of, or comment on, the Contractor's Safety and Health Plan, including the Site Specific Accident Prevention Plan or safety program shall not, in any way, relieve the Contractor of any responsibility or liability for compliance with applicable regulations, NIH policies, or other requirements stipulated in the Contract.
5. Contents of Site Specific Accident Prevention Plan:
    a. In accordance with Appendix A, EM 3985-1-1.
6. Additional content requirements for the Contractor's Safety and Health Program are included in this section.
7. Safety Health Officer Qualifications: Submit the qualifications of the Safety and Health Officer as part of the Safety and Health Plan.
    a. The NIH Project Officer will review the qualifications and a personal interview may be required. The NIH Project Officer may reject anyone deemed "Not Qualified".

C. Hazardous Materials/Waste Management Plan: The contractor will coordinate the Safety and Health Program with the Hazardous Material/Waste Management Plan required by Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials." The Hazardous Material/Waste Management Plan is included in this section for reference only.

D. HAZMAT disposal Certificates: The contractor will provide copies of all permits and certificates for any hazardous materials disposed of off site as required by Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials."

E. Accident Reports. The Contractor must submit to the Contracting Officer and Project Officer a written report within three calendar days of any accident, fire, emergency, theft or incident in which any personal or property damage took place, regardless of any other notifications performed. Include a copy of each accident report that is submitted by the Contractor or Subcontractors to their insurance carriers, within seven calendar days after the date of the accident.

F. Gas Tests: Copies of the Daily Log of gas tests shall be provided to the Contracting Officer.

G. Severe Storm Plan. The Contractor shall develop and submit to the Contracting Officer within 14 calendar days of receipt of the notice to proceed a plan describing contractor procedures for responding to threats of Severe Weather.

## 1.5 SAFETY AND HEALTH OFFICER REQUIREMENTS

A. The Contractor's Site Safety and Health Officer(s) shall be categorized as a Full-time Safety Professional.

B. Full-time Safety Professional qualifications include:

1. Other Duties: He/She shall have no other duties.
2. Experience: Minimum of five years progressive experience managing safety programs on large projects comparable to this contract in scope and complexity.
3. Working Knowledge: Knowledgeable concerning all Federal, State, and Local regulations applicable to construction and industrial safety.
4. Certification: "Competent Person" certification in safety disciplines related to the work performed and possess verifiable training.
    a. Identify "Competent Persons" required by State and Federal safety standards for which they are not certified.
5. Training:
    a. Successfully completed the OSHA 500 Safety & Health Course.
        1) This requirement may be waived if individual possesses a safety and health degree or professional safety or industrial hygiene certification (i.e. CSP or CIH).
    b. Trained in, and possess current certification for CPR and First Aid.
6. Skills
    a. Capable of performing accident investigations and developing a concise report.
    b. Proficient in the development and presentation of "tool box" meetings and safety training.

C. Responsibilities:

1. The responsibility for safety lies with the Contractor. Each Contractor shall appoint an individual(s) responsible for safety on each contract. This individual(s) must be employed in a supervisory position, empowered by their employer to take corrective action; be present on the project while work is being performed; and spend the amount of time necessary to ensure the Contractor's compliance with safety requirements..
2. A safety inspection shall be performed and documented for each shift worked by the Contractor's Site Safety and Health Officer.
3. The Contractor Site Safety and Health Safety Officer shall be primarily responsible for ensuring Contractor's compliance with the safety requirements including but not limited to those provided in this Section. Without limiting the generality of the foregoing, the Contractor Site Safety and Health Officer shall:
    a. Review all Subcontractor and sub-tier contractor's Site-Specific Accident Prevention Plan and Activity Hazard Analysis for compliance with applicable safety standards.
    b. Perform or ensure that all Contractor, Subcontractors and sub-tier contractors' employees have received a site specific safety orientation prior to beginning work. Training will include discussion of the site specific Activity Hazards Analysis reports. This site specific orientation is in addition to the NIH's safety orientation.
    c. Perform daily safety inspections of the Contractor and Subcontractor's worksite to evaluate the project and to eliminate unsafe conditions and/or practices, and take the appropriate corrective action(s) as required.

d. Immediately report all injuries to personnel, vehicle accidents, near miss incidents and property damage and insure immediate corrective action is taken. Assist in the preparation of all accident investigations and reporting procedures and ensure reports are submitted within 24-hours to both the NIH Project Officer and ORF Safety Officer (safety@nih.gov).
e. Ensure appropriate, weekly safety meetings are held for all onsite employees, to include Subcontractors. Maintain documentation of training dates and times, topics discussed and attendees, with copies of records kept onsite.
f. Be responsible for the control, availability, and use of necessary safety equipment, including personal protective equipment and apparel for the employees.

D. Substitution and Replacement:

1. Replacement Directed by NIH: If NIH, in its sole discretion, determines the Contractor's Site Safety and Health Safety Officer is not performing duties in accordance with this Section, the Contractor shall replace the Officer with an individual meeting the requirements of this Section.
2. Replacement Requested by Contractor: The Site Safety and Health Safety Officer may not be removed from this contract or replaced without the NIH's advanced written approval.
3. Substitution: Contractor shall notify the NIH Project Officer whenever a Safety and Health Safety Officer cannot be on duty while work is being performed and shall submit the name(s) and qualifications of the individual assigned to perform said duties during the Officer's absence.

## 1.6 PRECONSTRUCTION SAFETY MEETING

A. Prior to commencing construction, representatives of the Contractor, including the Contractor's safety officer, general superintendent and one or more safety representatives, shall meet with the Contracting Officer for the purpose of reviewing Contract safety and health requirements.

1. The Contractor's Safety and Health Program shall be reviewed, and implementation of safety and health provisions pertinent to the Work shall be discussed.
2. The Contractor shall be prepared to discuss, in detail, the Contractor's site specific Safety and Health Plan including measures intended to control any unsafe or unhealthy conditions associated with the work to be performed under the contract.
3. This meeting may be held in conjunction with the preconstruction conference, if so directed by the Contracting Officer. The conduct of this meeting is not contingent upon a general preconstruction meeting.
4. The level of detail for the safety meeting is dependent upon the nature of the work and the potential inherent hazards.
5. The Contractor shall advise the Contracting Officer of any special safety restrictions he has established so that NIH personnel can be notified of these restrictions.
6. No later than 3 calendar days after the Preconstruction Safety Meeting, the Contractor shall distribute minutes of the meeting to each party present and to other concerned parties, including the Contracting Officer.

## 1.7 CONTRACTOR ORIENTATION

A. NIH Safety Orientation: Prior to commencing construction, ensure that all Contractor and Subcontractor Supervisors at any tier have completed the NIH Safety Orientation to be held by the NIH at a time and location to be specified by the NIH, prior to commencing work. The time expended and any associated costs such as travel time, parking, and other expenses are to be borne by the Contractor.

1. Orientation Registration: It is the responsibility of the Contractor and Subcontractor to contact the ORF Safety Officer to register each supervisor for orientation. Class registration must be scheduled at least 14-working days prior to the project start date, or the date that the supervisor is assigned to NIH
2. Orientation Schedule: Contact the ORF Safety Officer at: (301) 496-3353 for the orientation schedule

## 1.8 COMPLIANCE WITH REGULATIONS

A. The work, including contact with or handling of hazardous materials, disturbance or dismantling of structures containing hazardous materials, and disposal of hazardous materials, shall comply with the applicable requirements of 29 CFR Parts 1910 and 1926, and 40 CFR Parts 61, 261, 761 and 763 and any other requirements contained in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials."

B. Work involving disturbance or dismantling of asbestos or asbestos containing materials, demolition of structures containing asbestos and removal of asbestos, shall comply with 40 CFR Part 61, Subparts A and M, and 40 CFR Part 763.

C. Work shall additionally comply with all applicable state and local safety and health regulations.

D. In case of a conflict between applicable regulations, the more stringent requirements shall apply.

E. Contractor Responsibility: The Contractor shall obtain all required permits for work to be performed. The Contractor shall assume full responsibility and liability for compliance with all applicable codes, standards and regulations pertaining to the health and safety of personnel during execution of the Work, and shall hold the Government harmless for any action on the Contractor's part, or that of the Contractor's employees or subcontractors, that results in illness, injury or death.

F. Safety and Health Programs: The Contractor shall have written safety and health programs that, at a minimum, address and are in compliance with the following:

1. Contractor’s Construction Risk Assessment (CRA) and Interim Life Safety Measures (ISLM) plan developed for the project
2. 29 CFR Parts 1910 and 1926.
3. U.S. Army Corps of Engineers Safety and Health Requirements Manual, (EM 385-1-1, 11/3/03)
4. Other Reference Standards as applicable.

5. Permits, Inspections, Tests, and Reports: The required permits inspections, tests, and reports made by the Contractor, subcontractors, specially trained technicians, equipment manufacturers, and others as required, shall be at the Contractor's expense.

1.9 ACCIDENT PREVENTION

A. The Contractor shall be responsible for correcting hazardous conditions and practices. When more than one Contractor is working within a job site, any project management personnel shall have the authority to prevent physical harm or significant property damage.

1. Imminent Danger: If it is determined there is “Imminent Danger” the Contractor shall:
   a. Take immediate action to remove/safeguard workers from the hazard and stabilize or stop work until corrective actions can be implemented to eliminate the hazard.
   b. Immediately notify the NIH Project Officer and then the ORF Safety Officer.
   c. Each worker shall immediately report any condition known, or suspected to be unsafe or unhealthy to the Contractor Site Safety Officer. If there is no resolution of the concern at that level, the employee shall report the concern to the NIH Project Officer.

1.10 ON-SITE FIRST AID

A. At least one person shall be available at the work site at all times to render first aid. This person must have a valid certificate in first-aid training from the U.S. Bureau of Mines, the American Red Cross, or equivalent verifiable training program. A minimum ratio of one such qualified person for every 25 employees shall be maintained throughout the project. Additionally, the Contractor shall:

1. Post emergency procedures which shall include telephone numbers and locations of facilities including, but not limited to, hospitals, physicians, police, fire and emergency medical services, in conspicuous locations at the job site and at all telephone locations.
2. Provide, in a readily accessible location, first-aid supplies of sufficient size and number to handle common first-aid incidents.
3. Regularly discuss actions to be taken during emergencies with the Contractor’s supervisory personnel and at “tool box” safety meetings.

1.11 USE OF EXPLOSIVES

A. Use of explosives shall be prohibited. Explosive actuated tools (ex: nailguns, etc) shall not be used or brought to the project site without prior written approval from the Project Officer. Such approval shall not relieve the Contractor of responsibility for injury to persons or for damage to property due to the use of such explosives.

1.12 FIRE PREVENTION

A. The Contractor shall ensure that the fire prevention measures on-site are in accordance with OSHA, NIH Fire Department policies, and NFPA standards. Approved safety cans (approved or

listed by a nationally recognized testing laboratory) shall be used for flammable and combustible liquids. Fire extinguishers shall be provided where required.

1. Open Flame Devices: Prohibit the use of unapproved fuel-burning types of lanterns, torches, flares or other open-flame devices on NIH property.
2. Hot Work Permit: Open flame welding and spark producing equipment and tasks require the Contractor to secure a “Hot Work Permit” from the NIH Fire Department. This can be obtained by calling the NIH Fire Marshall at (301) 496-0414

## 1.13 WORK UNDERGROUND OR IN CONFINED SPACES

A. Entry into Confined Spaces: If work requires entry into confined spaces, the Contractor shall read and follow the requirements of the NIH Confined Space Entry Program. The Contractor’s Confined Space Entry Program must meet or exceed these requirements.

1. The Contractor shall provide the NIH Project Officer a copy of its Confined Space Entry Program as part of the Site Specific Accident Prevention Plan Submittal.
2. Should the Contractor employ Subcontractors to work in confined spaces, it shall be the Contractor’s responsibility to submit the required documentation for each Subcontractor.
3. Work shall not start in a confined space until the required submittals have been made. In the event the Contractor does not comply with these regulations, ACCESS WILL BE DENIED and the NIH Project Officer notified..

B. Work underground or in confined spaces shall comply with the NIH Division of Engineering Services Instruction Manual 1340-7, "Precautions and Procedures for Entering Manholes or Other Below Grade Confined Spaces" (DES INST 1340-7). A copy of the instruction may be obtained from the Project Officer on request.

C. Work shall also comply with appropriate MOSHA and OSHA regulations including but not limited to 29CFR 1910.146 and COMAR 09.12.32B

D. The Contractor shall remove water and debris and properly vent manholes before commencement and during execution of work in manholes.

## 1.14 ELECTRICAL

A. The Contractor shall appoint an individual responsible for the electrical safety of each work team to restrict entry to dangerous locations to those authorized by him jointly with NIH.

B. Electrical – Safe Clearance Procedures

1. Entry into High Voltage Areas: Work under this contract may require entry into High Voltage Areas.
2. In the event entry is required, the Contractor is obligated to identify any High Voltage areas that may be involved in work under this contract. Before entry into a High Voltage work area the Contractor shall notify the NIH Project Officer.
3. To prevent employee exposure or damage to electrical systems the Contractor shall exhaust all options and means to de-energize live electrical parts.

C. Electrical arc welding equipment shall not be connected to the building power supply.

## 1.15 GAS PROTECTION

A. The Contractor shall have one or more employees properly trained in operation of gas testing equipment and formally qualified as gas inspectors who shall be on duty during times workmen are in confined spaces. Their primary functions shall be to test for gas and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, gas tests shall be made at least every 2 hours or more often when character of ground or experience indicates gas may be encountered. A gas test shall be made before workmen are permitted to enter the excavation after an idle period exceeding one-half hour.

B. Readings shall be permanently recorded daily, indicating the concentration of gas, number and location of drilled piers, point of test, date, and time of test.

C. Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. A check by NIH is required prior to entering areas that contain hazardous or oxygen-deficient atmospheres. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and Government personnel.

## 1.16 SEVERE STORM PLAN

A. The Contractor shall develop and maintain a Severe Storm Plan and submit a copy to the Contracting Officer for information. The Contracting Officer will review the plan for general content and for the adequacy of the contractor's provisions to protect NIH property entrusted to the contractor as part of the project. The Contracting Officer reserves the right to require improvements to the plan for the protection of NIH personnel and property. The Contracting Officer assumes no liability for damage to Contractor Equipment or work not turned over to NIH which might be damaged by severe weather, regardless of the effectiveness of the contractor's Severe Storm Plan.

B. In the event that the National Weather Service or the Project Officer issues a severe storm warning for the Bethesda, MD area, the Contractor shall:

1. Secure outside equipment and materials and place materials susceptible to damage in protected locations.
2. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
3. Ensure that temporary erosion controls are adequate.
4. Provide the Project Officer with emergency contact information and provide for rapid response of contractor forces to correct project related damage during and immediately after a storm warning period.

C. The Contractor is responsible for completing routine severe storm preparations prior to vacating the project site at the close of each business day regardless of the weather forecast or active severe storm warnings.

## 1.17 MATERIAL DELIVERIES

A. Whenever practicable, deliveries shall be made during regular NIH working hours and only when the Contractor's representative is available to receive them. Deliver material in approved containers and with properly licensed vehicles and operators. Open delivery vehicles are not permitted. Deliver materials in fully closed vehicles or tarp covered vehicles. All dump trucks shall be fully covered while in transport to and from the unloading site. All loads shall be securely fastened until unloading. Engines shall not be left running while vehicles are loading, unloading, waiting or parked. Do not block roads, walks, building entrances/exits, fire hydrants and standpipes, exterior tanks or building gas connections.

## 1.18 HAZARDOUS MATERIALS

A. The Contractor shall bring to the attention of the Contracting Officer, or the Contracting Officer's authorized representative, any materials encountered during execution of the Work that the Contractor suspects are hazardous. The Contracting Officer shall determine whether the Contractor shall perform tests to determine if the material is hazardous. If the suspected material is leaking or spilling from its location the contractor is to contact the NIH Fire Department immediately.

B. If the Contracting Officer directs the Contractor to perform tests on suspected hazardous materials and the material is found to be hazardous, or if the material is found to be hazardous without Contractor testing, and/or if additional protective measures are required, a change to the Contract price may be provided, subject to the applicable provisions of the Contract.

C. Asbestos and Contractor Personnel Asbestos Training: Ensure that all workers have received and documented initial and annual Asbestos Awareness training prior to the start of work.

## 1.19 ADDITIONAL NIH SAFETY REQUIREMENTS

A. Excavating & Trenching: Coordination with the NIH Project Officer shall be required for work performed.

B. Construction activities that pose a potential risk of exposure to contaminated soil (such as excavations) shall be supervised by personnel who have a current 40-hour Hazardous Waste Supervisor’s certification. These individuals shall be able to identify the potential need for upgrading the level of health and safety protection. All personnel working in direct contact with contaminated soil shall have a current 40-hour Hazardous Waste Certification and medical monitoring, in accordance with OSHA regulations. The Contractor is responsible for soil sampling and air monitoring to determine hazards and exposures to their employees.

C. Individuals who operate hoisting equipment shall possess the appropriate certification (e.g. National Commission for the Certification of Crane Operators). A copy of the certification(s) shall be submitted to the NIH Project Officer prior to commencing work involving hoisting activities.

D. Work Glove Policy: To reduce the possibility of hand injuries the Contractor shall implement a policy that requires the use of gloves for all personnel under their control. In certain

circumstances, it shall be the responsibility of the Contractor to supply the proper gloves to perform the task.

E. Chemical Exposure Plan: The Contractor shall submit a Chemical Exposure Plan for any products containing isocyanates, methylene chloride, lead, silica, hydrofluoric acid and processes involving floor sealers, traffic coatings, terrazzo sealers, specialty paints or any other chemical which can produce nuisance odors. The plan shall include employee exposure control methods, isolation methods to prevent spread of chemicals and odors outside the work area and safeguarding of the NIH employees and public. Material Safety Data Sheets for each chemical must be maintained on site.

F. Protection of the Public: The Contractor shall submit a plan for the protection of the public on or adjacent to construction and demolition operations.

G. The Contractor shall comply with all established NIH Standards, Codes and Regulations and obtain appropriate approvals from the NIH Divisions of Safety, Health, Security and Fire Protection

H. The Contractor shall comply with all established NIH Standards, Codes and Regulations and obtain appropriate approvals from the NIH Divisions of Safety, Health, Security and Fire Protection.

I. The Contractor shall additionally comply with all requirements contained in the U.S. Army Corps of Engineers Safety and Health Requirements Manual, (EM 385-1-1, 11/3/03)

J. No work shall be performed in any area occupied by the public or NIH employees unless approved by the Project Officer.

K. In the event of an emergency in a construction site that has been secured with a chain, the NIH Fire Department will cut the chain to gain entry. The Contractor shall be responsible for a new chain.

L. Accident Treatment and Records: The Contractor shall post emergency first aid information and NIH emergency Telephone Numbers at the work site.

M. NIH Emergency Telephone Numbers: Emergency response for medical and other emergencies will be provided by the Government. The Division of Public Safety has implemented 9-1-1 service on the NIH Campus. Calls requesting the assistance of the NIH Police or Fire Department (fires, ambulance, rescue or hazardous materials incidents) are received at a state of the art Emergency Communications Center where trained and certified Emergency Services Dispatchers ensure that the appropriate NIH Police and/or Fire Department personnel and equipment are promptly dispatched. Contractors shall instruct their employees to immediately report any fire even if the fire has been extinguished as well as any hazardous material spill, ambulance or rescue emergency.

| | |
|---|---|
| ON-CAMPUS Emergency (Police/Fire/Rescue) | Dial 9-1-1 |
| TTY Telephone Line | 496-0063 |
| NIH Police Non-Emergency | 496-5685 |
| NIH Fire Department Non-Emergency | 496-2372 |
| NIH Fire Prevention Section | 496-0487 |
| NIH Occupational Safety and Health Branch | 496-2960 |

| | |
|---|---|
| OFF-CAMPUS Emergency POLICE & FIRE/RESCUE | Dial 9-9-1-1 |
| (For off-campus locations when using a telephone with an NIH exchange, e.g. 496, 402,435, 480 or 594) | |

N. Safety Clearance Procedures (Lockout/Tagout Tag System). The following Lockout/Tagout procedures will be followed unless more stringent procedures are required by current laws and regulations. The following procedures do not relieve the contractor from any more stringent requirements of the applicable codes and regulations. The safety of contractor and NIH personnel in areas impacted by the project remains the contractor's responsibility during construction.

1. Lockout/Tagout procedures shall be in accordance with OSHA 29 CFR 1910 and OSHA 29 CFR 1926. Lockout/Tagout procedures shall be included in the Contractor's Safety and Health Plan.
2. Contractor shall ensure that each employee is familiar with and complies with these procedures.
3. The Project Officer will, at the Contractor's request, apply lockout tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make the particular NIH equipment safe to work on.
4. No person, regardless of position or authority, shall operate any switch, valve, or equipment that has an official lockout/tag out tag attached to it, nor shall such tag be removed except as provided in this section.
5. No person shall work on any equipment that requires a lockout tagout tag unless he, his immediate supervisor, project leader, or a subordinate has in his possession the keys to the required lockout/tagout tags.
6. When work is to be performed on electrical circuits, the work shall be performed only by qualified personnel following the required safety procedures.
7. A Contractor's supervisor who is required to enter an area protected by a lockout/tagout tag will be considered a member of the protected group provided he notifies the holder of the tag stub each time he enters and departs from the protected area.
8. Identification markings on building light and power distribution circuit breakers shall not be relied on for establishing safe work conditions.
9. Before clearance will be given on any equipment other than electrical (generally referred to as mechanical apparatus), the apparatus, valves, or systems shall be secured in a passive condition with the appropriate vents, pins, and locks.
10. Pressurized or vacuum systems shall be vented to relieve differential pressure completely.
11. Vent valves shall be lockout/tagout tagged open during the course of the work.
12. Where dangerous gas or fluid systems are involved, or in areas where the environment may be oxygen deficient, system or areas shall be purged, ventilated, or otherwise made safe prior to entry. See paragraph "Gas Protection."

13. Tag Placement

    a. Lockout/tagout tags shall be completed in accordance with the regulations printed on the back thereof and attached to any device which, if operated, could cause an unsafe condition to exist.

b. If more than one group is to work on any circuit or equipment, the employee in charge of each group shall have a separate set of lockout/tagout tags completed and properly attached and locked.
c. When it is required that certain NIH owned and operated equipment be tagged, the NIH will review the characteristics of the various systems involved that affect the safety of the operations and the work to be done; take the necessary actions, including voltage and pressure checks, grounding, and venting, to make the system and equipment safe to work on; and apply such lockout/tagout tags to those switches, valves, vents, or other mechanical devices needed to preserve the safety provided. This operation is referred to as "Providing Safety Clearance."

14. Tag Removal

a. Lockout/tagout tags shall be removed only by those persons who initiated the lockout/tagout tag and who retain possession of the keys. Otherwise, lockout/tagout tags may be removed only with the authorization of the Project Officer.

## 1.20 PERSONNEL PROTECTIVE EQUIPMENT

A. Special facilities, devices, equipment and similar items used by the Contractor in execution of the work shall comply with 29 CFR, Part 1910, Subpart I and other applicable regulations.

## 1.21 SAFETY PERFORMANCE

A. If the Contractor experiences ongoing safety concerns such as a Lost Work Day Case or Recordable Incident Rate greater than the Bureau of Labor Statistics National Average for their respective industry, experiences repeated violations of safety and health rules and regulations or “Imminent Danger” situations; or fails to abate violations in a timely manner, the Contractor shall be subject to the following action at the NIH Project Officer’s discretion:

1. Removal and replacement of management personnel.
2. Submitting a written Safety Recovery plan to the NIH Project Officer detailing what changes will be made to their safety program and a timeline as to when the changes will be implemented.
3. Hiring an independent safety consultant who shall audit the Contractor’s procedures and operations. The consultant shall compile a plan detailing what changes the Contractor shall implement. This report shall be submitted to the NIH Project Officer.
4. Conduct a “Safety Stand Down” (suspend all work or any action thereof). Suspended work shall not be allowed to resume until the Contractor has completed the following actions for review and acceptance by the NIH Project Officer.
   a. Hazardous conditions leading up to the Safety Stand Down shall be abated.
   b. Training of such type and duration shall be conducted to educate personnel on the awareness of, identification of, and correction of hazards leading up to the stand down.

PART 2 - PRODUCTS

2.1 Safety and Health Programs: The Contractor shall submit copies of the written site specific project safety and health plan and emergency action procedures, as applicable to the work scope, as required as a result of the safety meeting, or as required by OSHA 29 CFR, Part 1926 including but not necessarily limited to the procedures and programs that support the requirements of the following:

A. Designation of Safety Competent Person.

B. Occupational Noise Exposure.

C. Fall Protection.

D. Personnel Protective Equipment.

E. Control of Hazardous Energy.

F. Hazardous Materials Waste Management Plan (draft if final plan has not been accepted).

G. Electrical Safety Related Work Practices.

H. Lead.

I. Asbestos.

J. Respirator Protection.

K. Confined spaces.

L. Emergency evacuation and reporting.

2.2 Contractor's Safety and Health Plan: In addition to specific safety and health programs applicable to the project, Contractor shall submit to the Project Officer a copy of the firm's general Safety and Health Plan listing emergency procedures and contact persons with home addresses and telephone numbers.

2.3 Permits: If hazardous materials are disposed of off-site, submit copies of shipping manifests and permits from applicable federal, state or local authorities and disposal facilities, and submit certificates that the material has been disposed of in accordance with regulations as required in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material".

2.4 Accident Reporting: The Contractor must submit to the Contracting Officer a written report within three calendar days of any accident, fire, emergency, theft or incident in which any personal or property damage took place, regardless of any other notifications performed.

Include a copy of each accident report that is submitted by the Contractor or Subcontractors to their insurance carriers, within seven calendar days after the date of the accident.

A. Gas Test Reports: Submit copies of daily log of gas tests

## PART 3 - EXECUTION

### 3.1 EMERGENCY SUSPENSION OF WORK

A. When the Contractor is notified by the Contracting Officer, or the Project Officer, of non-compliance with the safety or health provisions of the Contract, the Contractor shall immediately, unless otherwise instructed, correct the unsafe or unhealthy condition.

1. If the Contractor fails to comply promptly, all or part of the work will be stopped by notice from the Contracting Officer.
2. When, in the opinion of and by notice given by the Contracting Officer, satisfactory corrective action has been taken by the Contractor, work shall resume.
3. The Contractor shall not be allowed any extension of time or compensation for damages in connection with a work stoppage for an unsafe or unhealthy condition.

### 3.2 PROTECTION OF PERSONNEL

A. The Contractor shall take all necessary precautions to prevent injury to the public, occupants, or damage to property of others. The public and occupants includes all persons not employed by the Contractor or a subcontractor.

B. Wherever practical, the work area shall be fenced, barricaded or otherwise blocked off from the public or occupants to prevent unauthorized entry into the work area.

1. Provide traffic barricades and traffic control signage where construction activities occur in vehicular areas.
2. Corridors, aisles, stairways, doors and exit ways shall not be obstructed or used in a manner to encroach upon routes of ingress or egress utilized by the public or occupants, or to present an unsafe or unhealthy condition to the public or occupants.
3. Store, position and use equipment, tools, materials, scraps and trash in a manner that does not present a hazard to the public or occupants by accidental shifting, ignition or other hazardous activity.
4. Store and transport refuse and debris in a manner to prevent unsafe and unhealthy conditions for the public and occupants. Cover refuse containers, and remove refuse on a frequent regular basis acceptable to the Contracting Officer. Use tarpaulins or other means to prevent loose transported materials from dropping from trucks.

C. Alternate Precautions: When the nature of the work prevents isolation of the work area and the public or building occupants may be in or pass through, under or over the work area, alternate precautions such as the posting of signs, the use of signal persons, the erection of barricades or similar protection around particularly hazardous operations shall be used as appropriate.

D. Public Thoroughfare: When work is to be performed over a public thoroughfare such as a sidewalk, roadway or other site access way, the thoroughfare shall be closed, if possible, or other precautions taken such as the installation of screens or barricades. When the exposure to heavy falling objects exists, as during the erection of building walls or during demolition, special protection of the type detailed in 29 CFR, Parts 1910 and 1926 shall be provided.

## 3.3 ENVIRONMENTAL PROTECTION

A. Dispose of solid, liquid and gaseous contaminants in accordance with local codes, laws, ordinances and regulations.

B. Comply with applicable federal, state and local noise control laws, ordinances and regulations, including but not limited to 29 CFR, Part 1910.95 and 29 CFR, Part 1926.52.

## 3.4 HAZARDOUS MATERIALS

A. Requirements for hazardous Materials are contained in Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials."

END OF SECTION 015950

# SECTION 016000 - PRODUCT REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project, including manufacturers' standard warranties on products and special warranties.

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to product requirements and warranties. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

1.3 DEFINITIONS

A. The following definitions are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms that are self-explanatory and have well-recognized meanings in the construction industry.

B. "Products" are items purchased for incorporation in the work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and other terms of similar intent.

1. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.

C. “Sustainable Products and Materials” are products and materials with specific properties required to achieve Project Sustainability Goals outlined in the Project Sustainability Manual (available from the Project Officer).

1.4 QUALITY REQUIREMENTS

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source. Equipment of the same function shall be manufactured by the same entity, unless otherwise indicated.

B. Sustainable Products and Materials: To the fullest extent possible, provide products and materials which, when aggregated project wide, meet or exceed the sustainability goals for the project.

C. Compatibility of Options: When the contractor is given the option of selecting between 2 or more products for use on the project, the product selected shall be compatible with products previously selected, even if previously selected products were also options. Total compatibility among options is not assured by limitations within the Contract Documents, but must be provided by the contractor. Compatibility is a basic general requirement of product/material selections.

D. Manufacturers: Specific manufacturers and models of equipment and materials sited throughout the contract documents establish the desired performance and minimum quality of equipment and materials. The contractor may propose substitute manufacturers of equipment and materials unless specifically indicated otherwise. The contractor shall bear any cost related to the proposed substitution in all respects including but not limited to cost for establishing equality of the specified product and any coincidental construction costs directly related to the substitution. Rejection by the Project Officer does not allow for additional compensation.

1. The terms desired performance and minimum quality shall be interpreted in the broadest sense possible and are intended to imply attributes including but not limited to size limitations, aesthetic intent, compatibility with utility services shown, availability for project, technical performance characteristics, durability, and ease of maintenance.

E. Labels and nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on surfaces of products that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate nameplate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information:

    a. Name of product and manufacturer.
    b. Model and serial numbers.
    c. Operating data such as capacity, speed and ratings and similar essential operating data.

3. Protection: Labels and nameplates shall be protected from defacement and other damage during the remainder of the work.

## 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft.

1. Schedule product delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
2. Deliveries shall be addressed to the contractor and be scheduled to arrive at the worksite during normal working hours, unless otherwise authorized in writing by the Contracting Officer. The contractor shall take receipt of all deliveries. NIH will not accept delivery of materials.
3. Coordinate delivery with installation time to provide minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.
4. Deliver products to the site in an undamaged condition, in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.
5. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
6. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
7. Store heavy materials away from the project structure in a manner that will not endanger the supporting construction.
8. Store products subject to damage by the elements above ground, under cover in a weather-tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
9. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
10. Protect stored products from damage.

B. If, in the opinion of the Contracting Officer, delivered or stored items are considered damaged or defective, they shall be replaced at no sadditional cost to NIH.

C. Deliveries which require cranes shall be scheduled with the Project Officer a minimum of 15 working days prior to expected delivery.

## PART 2 - PRODUCTS

### 2.1 PRODUCT COMPLIANCE AND REQUIREMENTS

A. General: The compliance requirements, for individual products as indicated in the Contract Documents, are multiple in nature and may include generic, descriptive, performance, prescriptive, compliance with standards, conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.

B. Provide products complete with accessories, blocking, anchors, trim, finish, safety guards, devices and other items needed for a complete installation that provides the intended use and effect. Provide all ancillary materials and work shown, implied or required to fully integrate products into surrounding construction with fully finished appearance.

C. Standard Products: Products shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such products and shall be the manufacturer's latest standard design that complies with the specification requirements. Equipment shall essentially duplicate items that have been in satisfactory commercial and industrial use at least two years, or more if otherwise specified, prior to award of the contract or in lieu thereof shall have been used and operated in a test installation which, in the opinion of the Project Officer, duplicate its field performance for the same period of time. The Project Officer reserves the right to require the Contractor to submit evidence to this effect for his approval. When two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer.

D. Continued Availability: Products which, by nature of their application, are likely to be needed at a later date for maintenance and repair or replacement work, shall be current models for which replacement parts are available. Where specified and available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

E. Product Selection Procedures: Contractor's options for selecting products are limited by the Contract Document requirements including the Construction Contract Clauses, and governing regulations, and are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects. Required procedures include, but are not necessarily limited to, the following for various indicated methods of specifying:

1. Where the Specifications or Drawings list manufacturers' names or product designations, the Contractor may provide any product that complies with the requirements, subject to the following conditions:

    a. Manufacturers: Where a Specification or Drawings paragraph, subparagraph or note titled "Manufacturers" lists manufacturers' names, provide a compliant

product by one of the manufacturers named, or request a Substitution of another compliant product by another manufacturer.

b. Available Manufacturers: Where a Specification or Drawings paragraph, subparagraph or note titled "Available Manufacturers" lists manufacturers' names, provide a compliant product by one of the manufacturers named or by another manufacturer.

c. Products: Where a Specification or Drawings paragraph, subparagraph or note titled "Products" lists product designations, provide one of the products designated, or request a Substitution of another compliant product.

d. Available Products: Where a Specification or Drawings paragraph, subparagraph or note titled "Available Products" lists product designations, provide one of the products designated or another compliant product.

e. Basis of Design Product: Where a Specification or Drawings paragraph, subparagraph or note titled "Basis of Design Product" includes a product designation, provide the product designated, or request a substitution of another compliant product by one of the other manufacturers named, if any, or by another manufacturer.

2. Descriptive Requirements: Where Specifications or Drawings describe a product or assembly, listing exact characteristics required, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.
3. Performance Requirements: Where Specifications or Drawings require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated. Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.
4. Prescriptive Requirements: Where Specifications or Drawings require products that are produced using specified ingredients and components, including specific requirements for mixing, fabricating, curing, finishing, testing and similar operations in the manufacturing process, provide products produced in accordance with the prescriptive requirements that otherwise comply with Contract requirements.
5. Codes, Standards and Regulations: Where Specifications or Drawings require compliance with an imposed code, standard or regulation, select a product that complies with the codes, standards or regulations specified.
6. Visual Matching: Where Specifications or Drawings require matching an established sample, or matching existing conditions, the Project Officer decision will be final on whether a proposed product matches satisfactorily.
7. Visual Selection: Where specified product requirements include the phrase "as selected from manufacturer's standard colors, patterns, textures" or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Project Officer will select the color, pattern and texture from the manufacturer's product line.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 016000

# SECTION 017000 - EXECUTION REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This section includes certain general procedural requirements governing the Contractor's execution of the work, including, but not limited to the following:

1. Laying out of the work.
2. General installation of products.
3. Correction of Defective Work
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.

B. Substitutions: Changes in methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract shall comply with the procedures and conditions specified for Substitutions in the Construction Contract Clauses.

C. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to execution requirements. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |

| | |
|---|---|
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

D. Additional Requirements: Refer to the individual technical specification sections for additional execution requirements.

## 1.3 SUBMITTALS

A. Land Surveying Submittals: Where requirement for laying out work with land surveyor is indicated on drawings, provide the following submittals:

1. Surveyor Qualification Statement: Submit for review a statement attesting to previous experience from the land surveyor or professional engineer engaged to lay out the work. Include list of completed projects, with project names and addresses, and names and addresses of architects and owners.
2. Certificates: Submit a certificate signed by the land surveyor or professional engineer certifying that the location and elevation of improvements comply with requirements indicated.

B. Contractor Requests for Information (RFI): The Contractor shall submit Requests for Information (RFI) to the Project Officer. Upon receipt of an RFI, the Project Officer will review and coordinate a response. The response will be provided within 14 calendar days.

C. Manufacturer's Field Services Submissions: Where product manufacturers are required by the individual sections of the Specifications to provide qualified personnel to observe conditions of surfaces or other project conditions, installation or workmanship, start up or adjustment of equipment, tests or other activities, and to initiate instructions when necessary, the following shall be submitted to the Project Officer:

1. Qualifications: For approval, submit qualifications of observer at least 30 calendar days in advance of scheduled activities.
2. Report: For information, submit report of activities and findings within 15 calendar days after the successful execution of the specified work. Include logs and other documented data where applicable.

## 1.4 QUALITY REQUIREMENTS

A. Workmanship Standards: Initiate and maintain procedures to ensure personnel performing the work are skilled and knowledgeable in the methods and craftsmanship needed to produce the required levels of workmanship in the completed work. Remove and replace work that does not comply with workmanship specified and standards recognized in the construction industry for

the applications indicated. Remove and replace work damaged or deteriorated by faulty workmanship or replacement of other work.

B. Manufacturer's Instructions: Where installations include manufactured products, comply with manufacturer's applicable installation instructions and recommendations to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in the Contract Documents.

C. Specialists: Where the individual sections of the specifications require specialists to perform the work, comply with the requirements specified in the Construction Contract Clauses. The assignment of a specialist shall not relieve the contractor from complying with applicable regulations, union jurisdictional settlements or similar conventions, and the final responsibility for fulfillment of the entire requirements remains with the Contractor.

D. Minimum Quality and Quantity: The quality level or quantity shown or specified shall be the minimum required for the work. Except as otherwise indicated, the actual work shall comply exactly with that minimum or may be superior to that minimum within limits acceptable to the Contracting Officer. Specified numeric values are either minimums or maximums as indicated or as appropriate for the context of the requirements.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 LAYING OUT THE WORK

A. Projects Requiring Land Survey Work (when indicated on drawings):

1. Identification: NIH will identify existing benchmarks, control points and property line corner stakes.
2. Reference Points: Locate existing permanent benchmarks, control points and similar reference points before beginning work. Preserve and protect permanent benchmarks and control points during construction operations.

    a. Do not change or relocate existing benchmarks or control points without prior written approval of the Project Officer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate benchmarks or control points to the Project Officer before proceeding.
    b. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original control points.

3. Before proceeding to lay out the work, verify layout information shown on the drawings, in relation to existing benchmarks. If discrepancies are discovered notify the Project Officer promptly.
4. Establish and maintain a minimum of 2 permanent benchmarks on the site, referenced to data established by survey control points.

a. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
b. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the work.
c. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

5. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Make the log available for reference by the Project Officer.

B. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Additional underground utilities, not indicated on drawings, may be present and interfere with new work. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction including but not limited to the following:

1. Employ services of independent "Utility Finder" consultant to survey all proposed excavation areas.

a. Use ground penetrating radar, x-ray, metal detection, and video-scoping as appropriate and in combination as required to identify all utilities in excavation area.
b. Mark locations of utilities using temporary markers durable enough to remain in place until excavation activities commence. Survey location of located utilities and add survey information to project Record Documents.

2. Hand excavate test pits to determine absolute location of all utilities that may be damaged by excavation activities.
3. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping.
4. Furnish location data for work related to the project which must be performed by public utilities serving the Project site.

C. Layout the work using accepted surveying practices.

1. Establish benchmarks and markers to set lines and levels as needed to locate each element of the project.
2. Establish dimensions within tolerances indicated.
3. Inform installers of lines and levels to which they must conform.
4. Check the location, level and plumb of every major element as the work progresses.
5. Notify the Project Officer when deviations from required lines and levels exceed allowable tolerances.

## 3.2 EXAMINATION

A. Examine applicable substrates and conditions under which the work will be performed before starting construction operations.

B. If unsafe or otherwise unsatisfactory conditions are encountered take corrective action before proceeding.

C. Require installer of each major unit of work to inspect substrate to receive work, and conditions under which work will be performed, and report in writing to the Contractor any unsuitable conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Absence of written notice of unsuitable conditions will be relied upon to assure the Government that condition of substrate is acceptable.

D. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

## 3.3 PREPARATION

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

B. Take field measurements as required to fit the work properly. Indicate field measurements on shop drawings. Recheck measurements before installing each product.

1. Dimensions indicated on project drawings are approximate and intended to show general design intent. Contractor is responsible for all field measurements required to properly design, fabricate, fit and install products.
2. Survey existing floor slabs to determine actual deviation from “level”. Identify conditions that exceed tolerance specified for new concrete work and propose corrective action plan for approval by Project Officer.

C. Verify space requirements of items shown diagrammatically on drawings.

D. Drawing Verification: Check all drawings furnished immediately upon their receipt and promptly notify the Project Officer of any discrepancies. Figures marked on drawings shall in general be followed in preference to scale measurements. Large scale drawings shall in general govern small scale drawings. The Contractor shall compare all drawings and verify the figures before laying out the work or ordering custom furniture, equipment or material and will be responsible for any errors which might have been avoided thereby. Dimensions on drawings shall be checked for accuracy by the Contractor.

E. Expansion and Control Joints: Layout expansion and control joints at sufficient intervals as required or recommended by manufacturer for each product.

## 3.4 INSTALLATION

A. Locate the work and components of the work accurately.

1. Make vertical work plumb and horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and to maximize ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas.
4. Coordinate, layout and install pipes, conduits and other components as tight to underside of floor slabs above as possible except where this requirement compromises a zone system of above ceiling utility installation or compromises requirement to install components to maximize ease of maintenance.

B. Install products at the time and under conditions that will produce satisfactory results.

1. Maintain temperature, humidity and other weather controls for best performance.
2. Isolate units of non-compatible work to prevent deterioration.

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

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

E. Anchors and Fasteners: Provide anchors and fasteners as required to withstand stresses, vibration and physical distortion. Anchor each component securely in place, accurately located and aligned with other work.

1. Allow for building movement, including thermal expansion and contraction.

F. Mounting Heights: In no case shall exposed items be mounted at a height which violates the provisions of the Americans with Disabilities Act Accessibility Guidelines (ADAAG)/Uniform Federal Accessibility Standards (UFAS) for the application indicated. Refer questionable component mounting heights to the Project Officer for final decision.

G. Joints: Make like joints of uniform width within contiguous surfaces. Where joint locations in exposed work are not indicated, arrange joints for a uniform and balanced visual effect.

H. Control and Expansion Joints: Install control and expansion joints where shown on drawings, and where required or recommended by manufacturer for each product.to accommodate thermal or other movement without damaging product.

I. Adjust operating components for proper operation without binding.

## 3.5 CORRECTION OF DEFECTIVE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.

B. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and proper adjustment of operating equipment.

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

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

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

F. Remove and replace chipped, scratched or broken surfaces.

G. Re-install equipment, piping, conduits and other devices where Project Officer determines installation tighter to slab above is feasible and such re-installation is warranted to provide improved future construction flexibility or improved personnel circulation.

H. Relocate equipment, piping, conduits and other devices where Project Officer determines adjusted location would provide better access for maintenance.

## 3.6 PROGRESS CLEANING

A. Maintain the project work areas free of waste material and debris.

B. Effect daily cleaning activities designed to control contaminants in building spaces during construction and prior to occupancy.

1. Protect porous materials from exposure to moisture, dust or other contaminants.
2. Remove construction debris daily from construction site and render construction site “broom clean” at end of each work day.
3. During construction activities with high dust generation, augment daily construction cleaning with twice weekly vacuuming using wet/dry vacuum cleaner. High dust generation activities include but are not limited to demolition, cutting and patching, masonry cutting and installation, and installation and finishing gypsum board.

C. Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the work.

1. Remove liquid spills promptly.

D. Keep installed work clean. Clean installed surfaces in accordance with the recommendations of the manufacturer or fabricator of the product installed, using only the cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and will not damage exposed surfaces.

E. Remove debris from concealed spaces prior to enclosing the space.

F. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at the time of project completion.

G. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Enforce requirements strictly and dispose of material lawfully.

1. Comply with NFPA 241 for removal of combustible waste material and debris.
2. Do not hold waste materials more than 7 days during periods when the ambient temperature remains continuously less than 80 deg F or for more than 3 days when the temperature exceeds or is expected to rise above 80 deg F.
3. Handle and properly containerize hazardous, dangerous or unsanitary waste materials separately from other waste. Coordinate with Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material".

## 3.7 STARTING AND ADJUSTING

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

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

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

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

E. Coordinate with the commissioning process specified in Division 01 Section “General Commissioning Requirements”

## 3.8 PROTECTION OF INSTALLED CONSTRUCTION

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

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

END OF SECTION 017000

# SECTION 017310 - CUTTING AND PATCHING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

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

B. Definition: Cutting and patching includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and repair required to restore surfaces to their original condition.

C. Refer to other sections for other requirements and limitations applicable to cutting and patching individual parts of the work.

D. Coordinate cutting and patching with demolition requirements specified in Division 01 Section "Selective Demolition."

E. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to cutting and patching. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |

| | |
|---|---|
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

## 1.3 SUBMITTALS

A. Cutting and Patching Plan: Submit a written plan to the Project Officer through the Quality Control manager describing procedures at least 21 calendar days in advance of the time cutting and patching will initially be performed.

1. Include the following information, as applicable:

    a. Description of the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.
    b. Description of the anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in appearance and other significant visual elements.
    c. List of products to be used and entities that will perform work.
    d. Dates and hours of operation when cutting and patching will be performed.
    e. List of utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
    f. Compatibility and cohesion characteristics of patching compounds with adjacent materials.
    g. Details and engineering calculations showing integration of reinforcement with the original structure, where cutting and patching involves adding reinforcement to structural elements.

2. Approval by the Project Officer to proceed with cutting and patching does not waive the right to later require complete removal and replacement of unsatisfactory work.
3. Samples: Provide cutting and patching samples for the following items within 14 calendar days after notice to proceed in order that special reviews and coordination can be arranged with approval authorities.

    a. Where cutting and patching samples are indicated as a requirement on Drawings.

## 1.4 QUALITY REQUIREMENTS

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

1. The cutting and patching plan shall include but not be necessarily limited to work required at the following structural elements:

    a. Foundation construction.

b. Bearing and retaining walls.
c. Structural concrete.
d. Structural steel.
e. Lintels.
f. Timber and primary wood framing.
g. Structural decking.
h. Stair systems.
i. Miscellaneous structural metals.
j. Exterior curtain-wall construction.
k. Equipment supports.
l. Piping, ductwork, vessels, and equipment.
m. Structural systems of other construction.

B. Operational Limitations: Do not cut and patch operating elements, safety related systems, or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements, safety related systems or related components in a manner that would result in increased maintenance or decreased operational life or safety. Operating elements or safety related systems include but are not limited to the following:

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Water, moisture, or vapor barriers.
4. Membranes and flashings.
5. Fire protection systems.
6. Noise and vibration control elements and systems.
7. Control systems.
8. Communication systems.
9. Conveying systems.
10. Electrical wiring systems.
11. Operating systems of other construction.

C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Project Officer's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction that was previously cut and patched in a visually unsatisfactorily manner. When requested by the Contracting Officer, engage a Specialist who is specifically experienced in the work. Visual elements include but are not limited to the following:

1. Processed concrete finishes.
2. Stonework and stone masonry.
3. Ornamental metal.
4. Matched-veneer woodwork.
5. Preformed metal panels.
6. Firestopping.
7. Window wall system.
8. Stucco and ornamental plaster.
9. Acoustical ceilings.
10. Terrazzo.
11. Finished wood flooring.

12. Fluid-applied flooring.
13. Carpeting.
14. Aggregate wall coating.
15. Wall covering.
16. Mechanical system enclosures, cabinets, or covers.

1.5 EXISTING WARRANTIES

A. Remove, replace, patch, and repair material and surfaces cut or damaged during cutting and patching operations by methods and with materials in such a manner as not to void any existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections of these Specifications.

B. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Before cutting, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.

B. Before proceeding with cutting and patching involving two or more trades, meet at the project site with the Project Officer and the entities providing or affected by the cutting and patching. Site meeting should be incorporated into the Three Phases of Quality Control process managed by the Contractor's Quality Control Manager. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

C. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3.2 PREPARATION

A. Provide temporary support of work to be cut.

B. Protect existing conditions during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

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

D. Where existing services are required to be removed, relocated, abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

## 3.3 PERFORMANCE

A. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

B. Cutting: Cut existing construction using methods least likely to damage elements retained and adjoining construction. Where possible, review proposed procedures with the original installer and comply with the original installer's recommendations.

1. In general, use hand or small power tools designed for sawing or grinding, not for hammering and chopping.
2. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
3. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
4. Cut through concrete and masonry using a cutting machine, such as a Carborundum saw or a diamond-core drill.
5. Comply with requirements of applicable Division 01 sections where cutting and patching requires excavating and backfilling.
6. After utility services are bypassed, cut-off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
2. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Where removed walls or partitions extends one finished area into another finished area, patch and repair floor and wall surfaces to provide an even surface of uniform color, finish, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface that contains the patch after the area has received primer and other undercoats.
5. Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
6. Maintain integrity of fire barriers, vapor barriers and insulation.

7. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

D. Perform cutting and patching work listed in Division 01 Section "Work Restrictions" during NIH Unoccupied Hours.

## 3.4 CLEANING

A. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar items.

B. Thoroughly clean piping, conduit, and similar features before applying paint, restored pipe coverings, or other finishing materials.

END OF SECTION 017310

# SECTION 017320 - SELECTIVE DEMOLITION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This section includes the following:

1. Demolition and removal of selected portions of a building.
2. Demolition and removal of selected site elements.
3. Repair procedures for selective demolition operations.

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to selective demolition. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |

| | |
|---|---|
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |
| Division 23 | Sections for demolishing, cutting, patching, or relocating mech items. |
| Division 26 | Sections for demolishing, cutting, patching, or relocating electrical items. |

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them.

B. Remove and Salvage: Detach items from existing construction and deliver them to NIH **ready for reuse.**

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed.

1.4 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be salvaged, reinstalled or otherwise indicated to remain NIH property, demolished materials shall be removed from the site by the Contractor, with further disposition at Contractor's option.

B. Historical items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, an other items of interest or value to NIH, which may be encountered during selective demolition, shall remain NIH property.

1. Carefully remove and salvage each item or object in a manner to prevent damage, and deliver it promptly to NIH.
2. Cooperate with the NIH archaeologist or historical adviser.
3. <**Disposition Instructions**>

1.5 SUBMITTALS

A. Qualification Data: Provide qualifications of persons or firms performing demolition which demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other amplifying information. Qualification data must conform to that required in Division 01 Section "Quality Requirements" for Specialists or Professional Engineers as appropriate to the work.

B. Proposed noise-control or dust-control measures: Submit statement or drawing to the Contracting Officer for approval at least 14 calendar days prior to the start of demolition that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

C. Submit a proposed Demolition Plan to the Contracting Officer indicating the following:

1. Detailed sequence of selective demolition work, with starting and ending dates for each activity.
2. Interruption of utility services.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Locations of temporary partitions and means of egress.
6. Procedures and safety precautions to be used during demolition.
7. Trees and shrub protection.
8. Silt and erosion control handling.
9. Removal, transportation, and reclamation or disposal of removed materials.

10. Types of demolition activities that can be expected to interfere with NIH operations.
11. Procedures to ensure uninterrupted progress of NIH operations on-site.
12. Coordination of continuing NIH occupancy of portions of existing building and of partial occupancy by NIH of completed work.

D. Inventory: Items to be removed and salvaged.

E. Photographs or Videotape: Before work begins, submit sufficiently detailed photographs or videotapes showing predemolition existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Requirements for photographs and video tape are located in Division 01 Section "Photographic Documentation."

F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes. Comply with all requirements of Division 01 Section "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Materials."

## 1.6 QUALITY REQUIREMENTS

A. Demolition Firm Qualifications: Firm shall be a specialist in demolition work of similar materials and extent to that indicated for this Project.

B. Professional Engineer Qualifications: Comply with Division 01 Section "Quality Requirements."

C. Regulatory Requirements: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction. Comply with all regulatory requirements of those agencies and organizations having jurisdiction.

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Pre-Demolition Conference: Conduct conference at Project site to comply with requirements in Division 01 section "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.

3. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.

F. Demolition Plan: The Contractor shall prepare a detailed plan of the demolition work procedures and safety precautions to be used in the identification, demolition, trees and shrub protection, silt and erosion control handling, removal, transportation, and reclamation or disposal of removed materials. The plan shall be submitted to the Contracting Officer for review within 14 calendar days after receipt of the Notice to Proceed and at least 14 calendar days before the planned commencement of demolition activities.

1. Review and acceptance by NIH of the Contractor's demolition plan will not relieve the Contractor of any responsibility regarding damage from any demolition activity.

## 1.7 PROJECT CONDITIONS

A. NIH will occupy portions of the building immediately adjacent to the selective demolition area. Refer to Division 01 Section "Work Restrictions" for additional requirements.

1. Conduct selective demolition so NIH operations will not be disrupted.
2. Provide the Project Officer with not less than 72 hours notice prior to activities that will affect NIH operations. Include in the notification the expected demolition activities and expected level and duration of disturbance to NIH operations.

B. Safe access to existing walkways, corridors and other adjacent occupied or used facilities must be maintained. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from the Contracting Officer.

C. NIH will remove the existing items so indicated on the Drawings.

D. The Contractor shall remove and salvage the existing items so indicated on the Drawings.

E. The Contractor shall remove and reinstall the existing items so indicated on the Drawings.

F. Hazardous Materials: Except where noted, hazardous materials are not expected to be encountered in the work. If any material suspected of containing hazardous materials is encountered, do not disturb the material, immediately notify the Contracting Officer and the Project Officer. If suspected hazardous material is spilling out or leaking, notify the fire department immediately.

G. On-site storage or sale of removed items or materials will not be permitted.

H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

I. Fire Protection: Maintain fire-protection services during selective demolition operations.

J. Use of explosives is prohibited. Explosive actuated tools (ex: nailguns, etc) shall not be used or brought to the project site without prior written approval from the Project Officer. Such

approval shall not relieve the Contractor of responsibility for injury to persons or for damage to property due to the use of such explosives.

K. Contractor dumpsters will be permitted only if a location for the dumpster is shown on the contract drawings.

1.8 WARRANTIES

A. Existing Special Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials that do not void existing warranties. Verify existence of warranties with the Project Officer.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

A. Where available and appropriate for use, provide repair materials that are identical to existing materials.

B. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

C. Use materials whose installed performance equals or surpasses that of existing materials.

D. Use fireproof materials for dust barriers and other temporary enclosures. See Division 01 Section "Temporary Facilities and Controls" for additional barrier requirements.

E. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities to be removed have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled, and items to be removed and salvaged.

D. When encountering unanticipated mechanical, electrical or structural elements that conflict with the intended function or design, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Project Officer.

E. Engage a professional engineer to survey the condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.

F. Perform surveys as the selective demolition progresses to detect hazards resulting from the activities.

G. Do not start any construction activities in an existing laboratory until the NIH Division of Safety has inspected the space and certified it to be safe for construction work by putting a Division of Safety sticker on the door.

## 3.2 UTILITY SERVICES

A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by the Project Officer. See Division 01 Section "Project Management and Coordination" for additional requirements associated with utility shutdowns.

1. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities. See Division 01 Section "Temporary Facilities and Controls" for additional temporary utility information.
2. Provide not less than 15 calendar days notice to the Project Officer if shutdown of service is required during changeover.

C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving areas to be selectively demolished.

1. NIH will arrange to shut off indicated utilities when requested by Contractor.
2. Where utility services are required to be removed, relocated or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit after bypassing.
4. Do not start selective demolition work until utility disconnection and sealing have been completed and verified.

D. Smoke Detectors: Request a utility outage for all smoke detectors where demolition work is planned. Do not start work until smoke detectors are shut off.

## 3.3 PREPARATION

A. Dangerous Materials: If chemicals, gases, explosives, acids, flammable or other dangerous materials of unknown content or origin are found which are not shown on the drawings, contact the Project Officer immediately before proceeding with demolition.

B. Pest Control: Employ a certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations. See Division 01 Section "Temporary Facilities and Controls" for requirements to provide Integrated Pest Management on all NIH construction projects.

C. Temporary Site Control: Remove debris and conduct demolition operations in a manner to ensure minimum interference with roads, streets, walks, walkways, corridors, and other adjacent occupied or used facilities.

1. Do not close or obstruct streets, walks, walkways, corridors, or other adjacent occupied or used facilities without permission from the Project Officer.
2. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

D. Temporary Facilities: Conduct demolition operations in a manner to prevent injury to people and damage to adjacent building and facilities to remain. Provide for safe passage of people around selective demolition area. Provide temporary facilities in accordance with Division 01 Sections "Temporary Facilities and Controls" and "Temporary Traffic Controls" as applicable.

1. Erect temporary protection, such as walks, fences, railings, canopies and covered passageways, where required by authorities having jurisdiction.
2. Protect existing site improvements, appurtenances and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to prevent water leakage or damage to structure or interior areas.
5. Protect walls, ceilings, floors and other existing finish work that are to remain and are exposed during selective demolition operations.
6. Cover and protect furniture, furnishings and equipment that have not been removed.

E. Temporary Enclosures: Erect and maintain smoke tight and dustproof partitions and temporary enclosures to limit dust and dirt migration into remaining spaces and to separate areas from fumes and noise. Use fire retardant materials for all temporary enclosures.

F. Temporary Shoring: Provide and maintain shoring, bracing or other structural support to preserve stability and prevent movement, settlement or collapse of building to be selectively demolished. Strengthen or add new supports when required during the progress of selective demolition.

## 3.4 POLLUTION CONTROLS

A. Dust Control: Use temporary enclosures and other suitable methods complying with governing environmental protection regulations to limit the spread of dust and dirt.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, pollution, or slippery conditions.
2. Wet mop floors to eliminate trackable dirt, and wipe down walls and doors of demolition enclosure.

B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in accordance with applicable safety regulations.

C. Cleaning: Clean adjacent structures and site improvements of dust, dirt and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

## 3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete selective demolition within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically. Conduct work in an order that avoids transporting removed items and debris through areas with completed selective demolition work, and that allows for removal of items before supports for those items are removed in another area.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage adjoining construction to remain. Where possible, use hand or small power tools designed for sawing or grinding, not for hammering and chopping, to minimize disturbance of adjacent surfaces. Contractor is to use the correct tool for the work and operate it in accordance with the manufacturers instructions. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations, and maintain adequate ventilation when using cutting torches. See Division 01 Section "Fire Prevention Precautions for Hot Work."
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested and other dangerous or unsuitable materials, and promptly dispose of these materials off-site.
7. Lower removed structural framing members to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors or framing.
9. Dispose of demolished items and materials promptly.
10. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.

B. Existing Facilities: Comply with all regulations for using and protecting elevators, stairs, walkways, loading docks, building entries and other building facilities during selective demolition operations. Coordinate with the Project Officer for building-specific requirements.

C. Removed and Salvaged Items. Comply with the following:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to NIH.
4. Delivery to NIH: Transport the materials and equipment to the area on-site designated by the Contracting Officer or indicated on the drawings.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items. Comply with the following:

1. Clean and repair items to functional condition adequate for intended reuse. Paint damaged or deteriorated painted surfaces of equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Contracting Officer, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations after selective demolition operations are complete.

F. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

G. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

H. Concrete Slabs on Grade: Break up and remove concrete slabs on grade, unless otherwise shown to remain.

I. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

J. Resilient Floor Coverings: Remove floor coverings and adhesive, and prepare substrate for new floor covering, according to recommendations of the Resilient Floor Covering Institute (RFCI).

K. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

## 3.6 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Division 01 Section "Cutting and Patching."

C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

1. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to the manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.

E. Floor and Wall Surfaces: Patch and repair floor and wall surfaces in each space where demolished walls or partitions result in extending one finished area into another. Provide a flush and even surface of uniform color, texture and appearance.

1. Closely match texture and finish of existing adjacent surface.
2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
3. Where patching occurs in a painted surface, apply primer and other specified undercoats. Apply specified intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
4. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
5. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

F. Ceilings: Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

## 3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning of any materials removed during demolition is not permitted on NIH property.

C. Disposal: Transport demolished materials off NIH property and legally dispose of them.

## 3.8 SELECTIVE DEMOLITION SCHEDULE

A. Existing items to remain, be removed and/or be salvaged are indicated on the drawings.

END OF SECTION 017320

# SECTION 017350 - FIRE PREVENTION PRECAUTIONS FOR HOT WORK

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

### 1.2 SUMMARY

A. This section applies to safeguards to be observed in performing hot work, including welding, soldering, brazing and similar applications producing a spark, flame or heat.

B. Very specific requirements exist for performing hot work on the NIH campus. Any deviations from the requirements outlined in this section must be thoroughly coordinated with the Project Officer and the NIH Division of Public Safety.

C. This specification section is related to any and all specification sections with explicit or implicit reference to fire prevention and requirements for hot work including but not limited to the following Division 01 specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |

01 82 00 Demonstration and Training

D. Additional Requirements: Refer to the individual technical specification sections for additional requirements.

1.3 SAFETY PRECAUTIONS

A. Prior to commencing hot work operations, a positive determination shall be made that it is impractical to conduct the hot work in a shop area or outside of the building. Coordinate suitable locations for hot equipment operations agreeable to the Project Officer and the NIH Division of Public Safety.

B. Hazardous Work Permit

1. The Contractor shall ensure that operations involving the use of open-flame, spark-producing tools, or electrical arc welding equipment are not conducted until a Hazardous Work Permit has been issued by the NIH Division of Public Safety. The Contractor shall call the NIH Division of Public Safety at **301-496-0414** to obtain a permit. The permit shall be conspicuously posted at the work site at all times.

1.4 NOTIFICATION

A. The Contractor shall notify the Project Officer of the area of hot work operations for each day and of all subsequent changes that occur. A separate Hazardous Work Permit is required for each area in which hot work will be performed and for all subsequent changes that occur.

PART 2 - PRODUCTS - (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall not start work until all precautions noted in the "Hazardous Work Permit" have been implemented.

3.2 SAFEGUARDS

A. Hot work shall not be done in or near rooms or areas where flammable liquids or explosive atmospheres are present or thought to be present.

B. Insofar as possible, the Contractor shall remove and keep the area free from all combustibles, including rubbish, paper and waste within a radius of 35 feet (10.66 m) from hot work operations.

1. If combustible material cannot be removed, the Contractor shall furnish retardant blankets to cover such materials. At the direction of the Project Officer, floors, walls,

and ceilings of combustible material shall be wetted thoroughly with water before, during, and after operations sufficiently to afford adequate protection. Where floors have been wet down, personnel operating arc welding or cutting equipment shall be protected from possible shock.

C. The Contractor shall prevent the spread of sparks and particles of hot metal through openings or cracks in windows, doors, floors, walls, ceilings, roofs and ducts.

D. Cylinders of gas used in hot work shall be placed a safe distance from the work. The Contractor shall provide hoses and equipment free of deterioration, malfunction and leaks. Suitable supports shall be provided to prevent accidental overturning of cylinders. All cylinder control valves shall be shut off while not in use.

E. When hot work operations are completed or ended for the day, each location of the day's work shall be inspected by the Contractor at least 30 minutes after completion of operations to detect for hidden or smoldering fires and to ensure that proper housekeeping is maintained. The Contractor shall cleanup the area of work at the end of each shift or workday.

F. Where sprinkler protection exists, the sprinkler system shall be maintained without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, a wet rag may be used to shield the individual heads temporarily. The heads shall be inspected by the Contractor immediately after hot work operations cease, to ensure all materials have been removed from the heads and that the heads have not been damaged.

G. Fully-charged and operable portable fire extinguishers that are appropriate for the type of fire shall be available at all times during hot work operations.

H. If any of the above safeguards are not employed, or are violated, the Contracting Officer may, by written notice, stop the work until compliance is obtained. Such stoppage shall not relieve the Contractor from performing his work within the Contract period for the Contract price.

END OF SECTION 017350

# SECTION 017700 - CLOSEOUT PROCEDURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion requirements and inspection procedures
2. Final Completion requirements and inspection procedures
3. Warranties.
4. Instruction of NIH personnel.
5. Final cleaning.

B. Closeout requirements for specific construction activities are included in the individual sections in Divisions 02 through 33.

This specification section is related to any and all specification sections with explicit or implicit reference to closeout procedures. Specific submittal requirements of these related specification sections are not included in this section. Related sections include but are not limited to the following specification sections:

| | |
|---|---|
| 01 10 00 | Summary |
| 01 14 00 | Work Restrictions |
| 01 23 00 | Alternatives |
| 01 26 00 | Options |
| 01 29 00 | Payment Procedures |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 20 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 35 50 | Construction Security Requirements |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 00 | Construction Quality Control |
| 01 50 00 | Temporary Facilities and Controls |
| 01 54 80 | Use, Handling, Storage, Transporting, Accumulation, and Disposal of NIH Controlled Material |
| 01 59 50 | Safety and Health |
| 01 60 00 | Product Requirements |
| 01 70 00 | Execution Requirements |

| | |
|---|---|
| 01 73 10 | Cutting and Patching |
| 01 73 20 | Selective Demolition |
| 01 73 50 | Fire Prevention Precautions for Hot Work |
| 01 77 00 | Closeout Procedures |
| 01 78 10 | Project Record Documents |
| 01 78 23 | Operation and Maintenance Documentation |
| 01 82 00 | Demonstration and Training |

C. Substantial Completion is defined as that state when the Contractor has complied with the Contract requirements, except for minor deviations, and the project is sufficiently complete and capable of being occupied and used by NIH for the intended purpose. Achievement of Substantial Completion is determined by the Contracting Officer.

## 1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining the date of Substantial Completion, complete the following.

1. Provide supporting documentation for completion as indicated elsewhere in the Contract Documents and a statement showing an accounting of changes to the Contract Sum.
2. Submit copy of Contractor's punch list for each room or element of work, annotated by Contractor to indicate successful completion and inspection by Contractor of corrected work required by punch list.
3. Submit a list of incomplete items to the Project Officer. Indicate the value of incomplete construction, and reasons the work is not complete.
4. Obtain and submit any necessary releases enabling NIH unrestricted use of the project and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Make final changeover of permanent locks. Use 8 bit Lockwood cylinders in the locks. Set the cylinders for blank keys and transmit two blank keys for each cylinder to the Project Officer. Advise the NIH user personnel of changeover in security provisions.
6. Complete startup testing of systems and instruction of NIH operation and maintenance personnel.
7. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
8. Submit Operation and Maintenance Manuals, final project photographs, and final surveys as specified.
9. Submit draft or final warranty documents for Contracting Officer review for approval.
10. Complete final clean-up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
11. Record Documents (Record Document AutoCAD files, Record Prints, drawings, specifications, product data, and miscellaneous record documentation).

    a. Initial submission shall be made to the Project Officer prior to the Pre-final Inspection.
    b. NIH will review the submission and provide appropriate comments. If comments are significant the initial submission will be returned to the contractor for correction and re-submission incorporating the comments prior to the Final Inspection.

c. See Division 01 Section "Project Record Documentation" for additional requirements.

12. Provide all required submittals to the Contracting Officer.
13. Submit test/adjust/balance records.
14. Submit changeover information related to NIH occupancy, use, operation, and maintenance.
15. Submit all hard copy bound and organized final Construction Quality Control Documentation for inclusion in the Commissioning Record
16. All systems and zones shall have successfully passed all functional performance tests.

B. Inspection Procedures:

1. Substantial Completion Inspection corresponds to the Pre-Final Completion Inspection described in Division 01 Section "Construction Quality Control."
2. On receipt of a request for inspection, the Project Officer will either schedule the inspection or advise the Contractor of unfilled requirements. The Contracting Officer will prepare the Certificate of Substantial Completion following the inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
3. The Project Officer will repeat the inspection when requested and when assured that the work is substantially complete.
4. Results of the completed inspection will form the basis of the requirements for final completion.

1.4 SUBMITTALS

A. The following shall be submitted prior to final payment and closeout.

1. Manufacturer's cleaning instructions
2. Posted instructions
3. All required submittals
4. Final project warranty documents reflecting changes directed by any comments from the Contracting Officer's review of draft documents.

1.5 Project Closeout Work Plan. Contractor shall submit a Project Closeout Work Plan for each phase of occupancy to the Project Officer for approval at least twenty-one calendar days prior to the Substantial Completion Inspection of the phase to be occupied. The plan should include all scheduled inspections, instruction classes, items to be submitted, closeout dates for all functions and the required NIH and Contractor personnel for these functions that will be taking part.

1.6 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for Certification of Final Completion and Final Payment, complete the following. Note that the following are to be completed, submitted as appropriate, and approved by NIH as applicable prior to the final inspection and are not to be submitted for approval or otherwise at the final inspection unless specifically indicated. List exceptions in the request.

1. Submit final payment request with releases and supporting documentation not previously submitted and accepted.
2. Submit an updated final statement, accounting for final additional changes to the Contract price.
3. Verify that all required submittals have been provided to the Contracting Officer including but not limited to the following:

    a. Manufacturer's cleaning instructions
    b. Posted instructions
    c. Record Documents (Record Document AutoCAD files, Record Prints, drawings, specifications, product data, and miscellaneous record documentation) incorporating any changes required by the Contracting Officer as a result of the review of the submission prior to the pre-final inspection. See Division 01 Section "Project Record Documentation" for additional requirements.
    d. Final project warranty documents reflecting changes directed by any comments from the Contracting Officer's review of draft documents.

4. Submit a certified copy of the previous Substantial Completion inspection list of items to be completed or corrected. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance, and shall be endorsed and dated by the Contractor.
5. Submit Pest management Post Construction Survey and Certification.
6. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
7. Submit record documents and similar final record information.
8. Deliver tools, spare parts, extra stock and similar items.
9. Complete final clean-up requirements including touch-up painting of marred surfaces.
10. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date when NIH took possession of and assumed responsibility for corresponding elements of the work.

B. Re-inspection Procedure: The Project Officer will re-inspect the work upon receipt of notice from the Contractor that the project work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Contracting Officer.

1. Upon completion of re-inspection, the Project Officer will advise the Contracting Officer, who will prepare a Certificate of Final Completion, or the Contracting Officer will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled and are required for Final Completion.
2. 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 any additional NIH inspection costs in accordance with the Contract Clause entitled "Inspection of Construction."

## 1.7 WARRANTIES

A. Standard and special warranties required by the individual sections of the Specifications and coincidental warranties shall provide guarantees in terms of time limits or rights of NIH in addition to those contained in the Construction Contract clauses.

1. Manufacturer's disclaimers and limitations on product warranties do not relieve the contractor of the warranty on the work that incorporates the products.
2. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
3. Standard product warranties shall be preprinted written warranties published by individual manufacturers for particular products, and shall be specifically endorsed to NIH by the manufacturer.
4. Special project warranties shall be specifically written to incorporate particular requirements of the Contract Documents, and shall be endorsed to NIH by the entities responsible for the work, as stated in the individual section.
5. Coincidental product warranties shall be provided where available on a product incorporated into the work by virtue of the fact that the manufacturer of the product has published a warranty in connection with purchases and uses of the product without regard for specific applications except as otherwise limited by terms of the warranty.

B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of the Contract Documents. The contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether NIH has benefited from the use of the work through a portion of its anticipated useful service life.

D. Rejection of Warranties: The Contracting Officer reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

E. Where the Contract Documents require a special warranty, or similar commitment for the work or part of the work, the Contracting Officer reserves the right to refuse to accept the work on behalf of NIH until the contractor presents evidence that entities required to countersign such commitments are willing to do so.

F. Where a warranty is not specifically required by the Contract Documents but is available on a product incorporated into the work, by virtue of the fact that the manufacturer of the product has published a warranty in connection with purchases and uses of the product without regard for specific applications except as otherwise limited by terms of the warranty, that warranty shall be provided to NIH.

G. Submit written warranties to the Contracting Officer as required by the contract documents.

1. Draft copies of required warranty documents shall be submitted to the Contracting Officer for review in the specified format prior to warranty execution and prior to the date certified for Substantial Completion, unless an earlier time of submission is specified elsewhere in the contract documents or requested by the Contracting Officer.

    a. Submit three copies of draft warranty documents. All but one copy of the draft submission shall be returned to the Contractor for corrections and resubmission.

2. Warranties will comply with the requirements included in the technical specification sections.
3. Unless indicated otherwise warranties are to take effect on the date of Substantial Completion.
4. When the contract documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, provide a written document that contains the appropriate terms and identification, executed by the required parties.

    a. Refer to Division 02 through 33 sections for specific content requirements and particular requirements for submitting special warranties.

5. Following Contracting Officer review, correct draft warranty documents as required and submit three copies of each final warranty document properly executed by the contractor, subcontractor, supplier, or manufacturer at Final Completion.
6. Organize the warranty documents into an orderly sequence based on the Specification Divisions and Section Numbers.

    a. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
    b. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
    c. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation.
    d. Provide a typed description of each product or installation being warranted, including the name of the product, and the name, address, and telephone number of the Installer.

7. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty in each required manual. Refer to Division 01 Section "Operation and Maintenance Documentation" for requirements of Operation and Maintenance manuals.

H. When a designated portion of the work is completed and occupied or used by NIH, by a separate agreement with the contractor during the construction period, submit properly executed warranties within 14 calendar days after completion of that designated portion of the work.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 POSTED EQUIPMENT INFORMATION

A. Post critical information for equipment in location approved by Project Officer.

B. Critical Information: Critical information includes the following as recommended by equipment manufacturer or required by Project Officer:

1. Equipment Name, Manufacturer, Model Number and Serial Number
2. Safety precautions
3. Wiring and control (P&ID) diagrams where appropriate showing system layout
4. Critical start up and shut down precautions where appropriate

C. Format: Engraved, framed under glass or approved laminated plastic and/or other durable, permanent format as appropriate for each type of information. Postings exposed to the weather shall be made of weather-resisting materials or shall be suitably enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

## 3.2 FINAL CLEANING

A. General cleaning during construction is required by the General Conditions and included in Section H of the Contract.

B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial cleaning and maintenance program. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces. Use only those cleaning materials and methods recommended by the manufacturer of the surface material to be cleaned. Use cleaning materials only on surfaces recommended by cleaning material manufacturer. Comply with manufacturer's instructions.

C. Complete the following cleaning operations before requesting inspection for Final Completion.

1. Remove labels and stickers that are not permanent from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers and ratings.
2. Polish glossy surfaces to a clear shine.
3. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
4. Sweep exterior paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
5. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
6. Remove tools, construction equipment, machinery, and surplus material from Project site.
7. Remove snow and ice to provide safe access to building.
8. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials and substances from sight-exposed interior and exterior surfaces. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
9. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
10. Sweep exposed concrete floors broom clean followed by wet mopping in occupied and unoccupied spaces.
11. Clean resilient floor surfaces and finish with wax or other finish cleaning and buffing in accordance with manufacturer’s recommendations.
12. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
13. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or

broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

14. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

    a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

15. Internally clean the entire system of piping and equipment. Open dirt pockets and strainers, completely blowing down as required and clean strainer screens of accumulated debris.
16. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
17. Replace parts subject to unusual operating conditions.
18. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
19. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
20. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
21. Leave Project clean and ready for occupancy.

D. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the project of rodents, insects, and other pests.

E. Dust Control: Handle materials in a controlled manner with as little dust and over spray as possible.

F. Removal of Protection: Remove temporary protection and facilities installed for the protection of the Work during construction.

G. Compliance: Comply with the regulations of authorities having jurisdiction and with safety standards for cleaning and disposal operations. Do not burn or bury rubbish, waste, and/or excess materials on NIH property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of it lawfully.

H. Remaining Materials: Where extra materials of value are remaining after completion of associated work, they become NIH property. Arrange for disposition of these materials as directed by the Project Officer.

END OF SECTION 017700

# SECTION 017810 - PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, As-Built Electronic Drawing files and Record Documents Electronic Drawing files.

B. Related Sections: This specification section is related to any and all specification sections with explicit or implicit reference to Project Record Document including but not limited to the following Division 01 specification sections:

1. Division 01 Section “Summary”
2. Division 01 Section “Project Management and Coordination”
3. Division 01 Section “Construction Progress Documentation”
4. Division 01 Section “Quality Requirements”
5. Division 01 Section “Construction Quality Control”
6. Division 01 Section “Safety and Health”
7. Division 01 Section “Closeout Procedures”
8. Division 01 Section “Operation and Maintenance Documentation”
9. Division 01 Section “Demonstration and Training”
10. Divisions 02 through 33 sections for project record document requirements for products included in those sections.

C. Project Record Documents and samples are to be stored by the Contractor in the field office apart from the Contract Documents used for construction. Project Record Documents are not to be used for construction purposes. Record Documents shall be maintained in good order and in a clean, dry, legible condition and available at all times for the Contracting Officer/Project Officer’s inspection.

### 1.3 DEFINITIONS

A. As-Built Electronic Drawing files: Multiple Construction Electronic Drawing files, organized by building system and floor and registered spatially, that represent the final as-constructed building and components. See Section 1.5.B for detailed deliverables requirement.

B. Record Documents Electronic Drawing files: One composite file of As-Built Electronic Drawing files per building floor, in AutoCAD .dwg format, that includes links to equipment data in .pdf files. See Section 1.5.B for detailed deliverables requirement.

C. Record Product Data: As-built product data in .pdf format linked to Record Documents Electronic Drawing files. Paper copies where required. See Sections 1.5.A and 1.5.B for detailed deliverables requirement.

D. Equipment Inventory Card: Data sheet in Excel format for each NIH-numbered building system and component. See Section 1.5.B for detailed deliverables requirement.

E. Record Prints: Prints of Contract Drawings and Shop Drawings marked up to show actual as-built conditions. See Section 1.5.A for detailed deliverables requirements.

F. Record Specifications: As-built specifications in .pdf format marked up to reflect actual as-built conditions. Paper copies where required. See Section 1.5.A for detailed deliverables requirements.

G. Record Documents: Paper copies of project records, including:
   1. Record Prints
   2. Record Specifications
   3. Record Product Data
   4. Miscellaneous Record Submittals
   5. Administrative Project Record

## 1.4 MAINTENANCE OF RECORD DOCUMENTS AND CONSTRUCTION DRAWINGS

A. Maintenance of Record Documents: Project Record Documents and samples are to be stored by the Contractor in the field office apart from the Contract Documents used for construction. Project Record Documents are not to be used for construction purposes. Record Documents shall be maintained in good order and in a clean, dry, legible condition and available at all times for the Contracting Officer/Project Officer's inspection.

## 1.5 SUBMITTALS

A. Record Documents: Comply with the following:
   1. Record Prints and Specifications: Submit Record Prints and Record Specifications to the Contracting Officer/Project Officer for review and approval prior to final payment.
   2. Hard Copies: During Project Closeout and prior to final payment submit 2 hard copies of Record Documents.

B. Final Submittal of As-Built Electronic Drawing files and Record Documents Electronic Drawing files: During Project Closeout:
   1. Create, for each discipline or system, an As-Built Electronic Drawing file. Save in native format of authoring application.
      a. Architectural and Structural information is required in .dwg format.
      b. For other systems, if the native format is other than .dwg, save also in 3D .dwg format, with any custom (ARX) objects converted to native AutoCAD elements.
   2. Verify that all As-Built Electronic Drawing files (building, structure and building systems) represent as-built conditions, including Architectural Supplemental Instructions, Change Notices, and field changes.
   3. Verify that the As-Built Electronic Drawing files register in X, Y and Z dimensions and coordinates.

4. Create an Electronic Drawing composite file of As-Built Electronic Drawing files. Save as .dwg.
5. For each NIH-numbered system or component, create an Equipment Inventory Card using the Excel template provided by Project Officer. Use the NIH number as the name of the file.
6. Record Product Data: For each NIH-numbered system or component, create a single .pdf document with searchable text (graphical material may be scanned). Include, as applicable:
    a. Equipment Inventory Card
    b. Product Data
    c. Manufacturer's application, installation and start-up instructions
    d. Record of start-up and testing
    e. Spare parts list and sources
    f. Training Manuals/Videos
    g. Systems Manuals
    h. Warranties and contact information
7. Create a Bookmark within the .pdf file for each type of information included.
8. Use the NIH number as the name of the .pdf file.
9. For each NIH-numbered system or component, create a hyperlink within the Electronic Drawing composite single floor files in .dwg format to the corresponding .pdf file to create the Record Documents Electronic Drawing files.
10. Create an Electronic Drawing composite model in both .dwg format of all Record Documents Electronic Drawing files to permit viewing and navigation of entire virtual building.
11. Deliver to the Project Officer the following:
    a. As-Built Electronic Drawing files in native format. All must conform to file naming standards established by NIH. Put in folder named "As-Built Electronic Drawing Files."
        1) Architectural and Structural information is required in .dwg format.
        2) For other systems, if the native format is other than .dwg,, save also in 3D .dwg format, with any custom (ARX) objects converted to native AutoCAD elements. Put in a subfolder in the "As-Built Electronic Drawing Files" folder named "Electronic Drawing Native 3D". Conform to file naming standards established by NIH.
        3) Any object enablers required for native format files. For each, create a subfolder in the "As-Built Electronic Drawing Files" folder with an obvious name such as, "CADPIPE HVAC Enabler".
    b. Electronic Drawing composite files of As-Built Electronic Drawing files in .dwg format. All must conform to file naming standards established by NIH. Put in folder named "As-Built Electronic Drawing Files."
    c. Equipment Inventory Cards in .xls or .xlsx format. All must follow file naming convention defined in 5. above. Put in folder named "Equipment Inventory Cards."
    d. Record Product Data: All must conform to requirements defined in 6. – 8. above. Put in folder named "Record Documents Electronic Drawing Files."
    e. Record Documents Electronic Drawing Files in .dwg format. All must conform to file naming standards established by NIH. Put in folder named "Record Documents Electronic Drawing Files."
    f. Deliver three (3) electronic copies, each on an USB drive with folder structure intact.

PART 2 - PRODUCTS

2.1 RECORD DOCUMENTS ELECTRONIC DRAWING FILES

A. General: Prepare a Record Documents Electronic Drawing file for the project which is inclusive of all trades and work elements contained in the Work.

B. Project Officer Furnished Design Electronic Drawing Files: Project Officer will furnish design Electronic Drawing files prepared by the AE for the Contractor's use. Such provision of files is strictly for the convenience of the Contractor in pursuit of his Work and does not constitute a warrantee regarding the accuracy of such files. Contractor is solely responsible for the accuracy of the Coordination and Record Electronic Drawing files required by this specification. A/E design Electronic Drawing files have been prepared using the following software:

1. Architectural components: Autodesk Revit 2011
2. MEP Systems: Autodesk AutoCAD 2010 to 2012

C. Final As-Built Electronic Drawing files and Record Documents Electronic Drawing files Submittal: Deliver data in the following formats:

1. As-Built Electronic Drawing Files:
   a. Architectural components: AutoCAD format
   b. Structural components: AutoCAD format
   c. HVAC ducts and piping: Software product selected by subcontractor(s)
   d. Sprinkler piping: Software product selected by subcontractor
   e. Plumbing components including storm water, domestic water and laboratory water systems: Product selected by subcontractor(s)
   f. For any formats not directly compatible with AutoCAD, provide .dwg files also.
   g. For any formats other than .dwg, provide a 3D AutoCAD version (.dwg), with all elements in native AutoCAD format.
   h. If any products used require object enablers:
      1) Provide the object enablers.
      2) Provide a version of the file with all custom (ARX) objects converted to native AutoCAD elements.
2. Equipment Inventory Card Software: MS Excel .xls or .xlsx format
3. Record Product Data Software: Adobe .pdf format
4. Record Documents Electronic Drawing File: The Record Documents Electronic Drawing File shall be an AutoCAD file of a composite Electronic Drawing Files compiled from the As-Built Electronic Drawing Files.

2.2 RECORD PRINTS

A. Record Prints: During construction, maintain a set of blue or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document purposes.

1. Mark Contract Drawings or Shop Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:

a. Dimensional changes to the Drawings.
b. Revisions to details shown on the Drawings.
c. Depths of foundations below the first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directives.
k. Changes made following the Contracting Officer/Project Officer's written orders.
l. Details not on original Contract Drawings.

2. Mark record prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference to and mark Contract Drawings location.
3. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the work at the same location.
4. Mark important additional information that was either shown schematically or omitted from original Drawings.
5. Note alternate numbers, Change Order numbers, and similar identifications.
6. Responsibility for Markup: The individual, installer, subcontractor or other entity who obtained the record data shall prepare the markup on record drawings.

a. Accurately record information in an understandable drawing technique.
b. Record data as soon as possible after obtaining it. Record and check the markup prior to enclosing concealed installations.

B. Format: Identify and date each Record Print; include the designation "PROJECT RECORD PRINT" in a prominent location.

1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

## 2.3 RECORD SPECIFICATIONS

A. During the construction period, maintain three copies of the Project Specifications, including addenda and other modifications issued, for Project Record Document purposes.

1. Mark the Specifications to indicate the actual installation where the installation varies from that indicated in Specifications. Note related project record drawing information, where applicable. Give particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later.

a. In each Specification section where products, materials or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.

b. Record the name of the manufacturer, supplier, installer, and other information necessary to provide a record of selections made and to document coordination with record Product Data submittals and maintenance manuals.

2. Upon completion of markup, submit Record Specifications to the Project Officer for NIH records.

## 2.4 RECORD PRODUCT DATA

A. During the construction period, maintain one copy of each Product Data submittal for Project Record Document purposes.

1. Mark Product Data to indicate the actual product installation where the installation varies substantially from that indicated in Product Data submitted. Include significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation.
2. Give particular attention to information about concealed products and installations that cannot be readily identified and recorded later.
3. Note related Change Orders and markup of Record Drawings, where applicable.
4. Upon completion of markup, submit a complete set of record Product Data to the Project Officer.
5. Where record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as record Product Data.

B. See Section 1.5 Submittals above for instructions on preparation and delivery of Record Product Data.

## 2.5 RECORD SAMPLE SUBMITTAL

A. Immediately prior to the date of Substantial Completion, the Contractor shall meet with the Project Officer at the site to determine which of the Samples maintained during the construction period shall be transmitted to NIH for record purposes.

B. Comply with the Project Officer’s instructions for packaging, identification marking and delivery to the NIH sample storage space. Dispose of other samples in a manner specified for disposing of surplus and waste materials.

## 2.6 MISCELLANEOUS RECORD SUBMITTALS

A. Refer to other specification sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Prior to Final Acceptance, assemble completed miscellaneous records and place in good order, properly identified and bound or otherwise organized to allow for use and reference.

B. Submit to the Project Officer for NIH records.

C. Miscellaneous records include, but are not limited to, the following:

1. Field records on excavations and foundations.
2. Field records on underground construction and similar work.
3. Survey showing locations and elevations of underground lines.
4. Invert elevations of drainage piping.
5. Surveys establishing building lines and levels.
6. Authorized measurements utilizing unit prices or allowances.
7. Records of plant treatment.
8. Ambient and substrate condition tests.
9. Certifications received in lieu of labels on bulk products.
10. Batch mixing and bulk delivery records.
11. Testing and qualification of tradespersons.
12. Documented qualification of installation firms.
13. Load and performance testing.
14. Inspections and certifications by governing authorities.
15. Leakage and water-penetration tests.
16. Fire-resistance and flame-spread test results.
17. Final inspection and correction procedures.

## 2.7 ADMINISTRATIVE RECORD

A. Maintain comprehensive electronic file administrative record for the project including copies of the following:

1. Contracts and contract modifications
2. Correspondence
3. Records relating to payment requests and payment
4. Addenda
5. RFIs
6. ASIs
7. Change Orders
8. Meeting Minutes
9. Project Schedule
10. Project Sustainable Design and Construction documentation

# PART 3 - EXECUTION

## 3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one hard copy of each submittal during the construction period for Project Record Documents purposes. Post changes and modifications to Project Record Documents and Construction Electronic Drawing Files as they occur; do not wait until the end of the Project.

END OF SECTION 017810

# SECTION 017823 - OPERATION AND MAINTENANCE DOCUMENTATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This section includes administrative and procedural requirements for operation and maintenance manuals and instruction, including the following.

1. Preparing and submitting instruction manuals covering the care, preservation and maintenance of materials and finishes.
2. Preparing and submitting operation and maintenance manuals for equipment and building operating systems.
3. Instruction of NIH operating personnel in the operation and maintenance of building systems and equipment.

B. This specification section is related to any and all specification sections with explicit or implicit reference to operation and maintenance documentation including but not limited to the following Division 01 specification sections:

1. Division 01 Section “Summary”
2. Division 01 Section “Project Management and Coordination”
3. Division 01 Section “Construction Progress Documentation”
4. Division 01 Section “Quality Requirements”
5. Division 01 Section “Construction Quality Control”
6. Division 01 Section “Safety and Health”
7. Division 01 Section “Closeout Procedures”
8. Division 01 Section “Project Record Documents”
9. Division 01 Section “Demonstration and Training”

C. Additional Requirements: Refer to the individual Division 02-33 technical specification sections for specific operations and maintenance manual requirements for products and systems in those sections and additional requirements for the care and maintenance of materials and finishes, and for the operation and maintenance of the various pieces of equipment and operating systems.

### 1.3 QUALIFICATIONS

A. Operation and Maintenance Manual Preparation: In preparation of manuals, use personnel thoroughly trained and experienced in the maintenance of the material or finish involved, or in the operation and maintenance of the equipment or system involved.

1. Where manuals require written instructions, use the personnel skilled in technical writing where necessary for communication of essential data.
2. Where manuals require drawings or diagrams, use draftspersons capable of preparing drawings clearly in an understandable format.

B. Instructions for NIH Personnel: Use instructors thoroughly trained and experienced in the operation and maintenance of the equipment or system involved to instruct NIH operation and maintenance personnel.

1.4 DEFINITIONS

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

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

1.5 COORDINATION

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

1.6 SUBMITTALS

A. Initial Submittal: Submit to the Contracting Officer five (5) draft hard copies and one electronic copy of each manual at least two months before the Acceptance Phase as specified in Division 01 Section “General Commissioning Requirements”. Include a complete operation and maintenance directory (with relative hyperlinks to each document in the electronic version). The Contracting Officer will return four (4) copies of draft with comments for incorporation into the final submission.

1. Should comments be extensive, the Contracting Officer may require the Initial Submission to be repeated prior to scheduling a Final Inspection.
2. Initial submittal shall occur at the initial occupancy phase

B. Final Submittal: Submit five (5) copies and one electronic copy of each manual in final form at least two working days before the beginning of the Acceptance Phase. If comments on the Initial Submittal are extensive, the Contracting Officer may require additional time in advance of the Acceptance Phase. Contracting Officer will provide return a copy with comments within 14 calendar days after the beginning of the Acceptance Phase.

1. Correct or modify each manual to comply with the Contracting Officer’s comments. Submit five (5) hard copies and one electronic copy of each corrected manual within 14 calendar days of receipt of Contracting Officer’s comments.

PART 2 - PRODUCTS

## 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Provide a comprehensive Operation and Maintenance Documentation Directory which provides a quick reference document for all the manuals provided for the project.

B. Organization: Include a section in the directory for each of the following:

1. Systems and Subsystems.

a. List systems and subsystems alphabetically. Include references to operation and maintenance manuals that contain information about each system and subsystem.

2. Equipment.

a. List equipment for each system and subsystem, organized alphabetically by system. For pieces of equipment not part of system or subsystem, list alphabetically in separate list.

3. Tables of contents.

a. Include a copy of the table of contents for each emergency, operation, and maintenance manual.

C. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the contract documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## 2.2 MANUALS, GENERAL

A. Organization and Content: Organize each manual into separate sections for each related product or piece of equipment. To the extent applicable, each manual shall contain a title page, table of contents, general information, copies of Product Data, written text, drawings and copies of each warranty and service contract issued.

1. Title Page: Provide a title page in a transparent, plastic envelope as the first sheet of each manual. As a minimum, provide the following information:

a. Subject matter covered by the manual.
b. Name and address of the Project.
c. Date of submittal.
d. Name, address, and telephone number of the Contractor.
e. Cross-reference to related products in other operation and maintenance manuals, if applicable.

2. Table of Contents: After title page, include a typewritten table of contents for each volume, arranged systematically by specification section according to the specifications format. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume. Where more than one volume is required to accommodate the data, provide a comprehensive table of

contents for all volumes in each volume of the set. The hard copy Table of Contents and Indexes shall be the printed version of the active hyperlink indexes of the electronic version.

3. General Information: Provide a general information section immediately following table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the subcontractor or installer and the maintenance contractor. Clearly delineate the extent of responsibility for each of these entities. Include a local source for replacement parts for equipment.
4. Product Data: Where the manuals include manufacturer's standard printed data, include only those sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where the project includes more than one item contained in the product data, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation, and delete references to information that is not applicable.
5. Written Text: Prepare written text to provide necessary information where manufacturer's standard printed data is not available, and the information is necessary for proper maintenance of materials or finishes, or for proper operation and maintenance of equipment or systems. Prepare written text where it is necessary to provide additional information or to supplement data included elsewhere in the manual. Organize text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operation or maintenance procedure.
6. Drawings: Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.
7. Warranties, and Service Contracts: Provide a copy of each warranty or service contract in the appropriate manual for the information of NIH operating personnel. Provide written data outlining procedures to follow in the event of product failure. List circumstances and conditions that would affect the validity of warranty.
8. Where required for full understanding, include a copy of applicable Project Record Drawings. Do not use original Project Record Documents as part of operation and maintenance manuals.

B. Hard Copy Format: Prepare operation and maintenance manuals in the form of an instructional manual for use by operating and maintenance personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar products into a single binder.

1. Binders: For each manual, provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to receive 8-1/2-by-11-inch (115-by-280-mm) paper. Provide a clear plastic sleeve on the spine to hold labels describing contents. Provide pockets in the covers to receive folded sheets.

    a. Where 2 or more binders are necessary to accommodate data, correlate data in each binder into related groupings according to the Specifications table of contents. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the product.

b. Identify each binder on front and spine, with the printed type of manual Project title or name, and subject matter covered. Indicate volume number for multiple volume sets of manuals.

2. Dividers: Provide heavy paper dividers with celluloid-covered tabs for each separate section. Mark each tab to indicate contents. Provide a typed description of the product or major parts of equipment included in the section on each divider.
3. Protective Plastic Jackets: Provide protective, transparent, plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
4. Text Material: Where maintenance manuals require written material, use the manufacturer's standard printed materials, where available. If manufacturer's standard printed materials are not available, provide specially prepared data, neatly typewritten, on 8-1/2-by-11-inch, 20-lb/sq. ft. white bond paper.
5. Drawings: Where manuals require drawings or diagrams, provide reinforced, punched binder tabs on drawings and bind in with text.

    a. Where oversize drawings are necessary, fold drawings to the same size as text pages and use as a foldout.
    b. If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in the front or rear pocket of binder. Insert a typewritten page indicating drawing title, description of contents and reference to the applicable location in the manual.

C. Electronic Copy: All operations and maintenance data shall be provided in both hard copy (as indicated above) and electronic copy. All operation and maintenance data shall be TEXT SEARCHABLE (scanned versions are not acceptable).provided in a combination of the following file formats:

1. pdf format
2. Hypertext Mark Up Language format (*.html)
3. Microsoft Office file formats
4. Autocad v2007 or later

D. The electronic version of the Operation and Maintenance Manual shall be a series of files organized in a logical series of hierarchical subdirectories of the primary OM directory with a summary Index (located in that primary directory) with hyperlinks to the various documents that make up the content. The Index will typically be the electronic version of the printed table of contents for the hard copy with live RELATIVE hyperlinks Final OM Manual shall be provided on a portable hard drive large enough to hold the files with 50% excess storage capacity. Interim submissions for review may be provided on multiple DVDs as long as directory structure is maintained and clear.

## 2.3 PRODUCT MAINTENANCE MANUAL

A. Content and Organization: Organize manual into a separate section for each product, material, and finish. Order manual by specification section of the applicable product. Include the following for each product:

1. Source information. List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list :

a. Name, Address, Telephone number of Installer or supplier and maintenance service agent.
b. Cross-reference to Specification Section number and title in Project Manual.

2. Product information, Include the following, as applicable:

a. Product name and model number.
b. Manufacturer's name.
c. Color, pattern, and texture.
d. Material and chemical composition.
e. Reordering information for specially manufactured products.

3. Maintenance procedures: Include manufacturer's written recommendations and the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Schedule for routine cleaning and maintenance.
e. Repair instructions.

4. Repair materials and sources: Include lists of materials and local sources of materials and related services.
5. Warranties and bonds, Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

a. Include procedures to follow and required notifications for warranty claims.

## 2.4 EQUIPMENT OPERATION AND MAINTENANCE MANUAL

A. Content and Organization: Provide information needed for daily operations and management of systems and equipment. Organize manual into a separate section for each equipment, component, packaged/preengineered system, etc.. Order manual by specification section of the applicable product. Include the following for each component:

1. Source information. List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list :

a. Name, Address, Telephone number of Installer or supplier and maintenance service agent.
b. Cross-reference to Specification Section number and title in Project Manual.

2. Product information, Include the following, as applicable:

a. Product name and model number.
b. Manufacturer's name.
c. Color, pattern, and texture.
d. Material and chemical composition.
e. Reordering information for specially manufactured products.
f. Equipment identification with serial number of each component.

g. Equipment function.
h. Operating characteristics.
i. Limiting conditions.
j. Performance curves.
k. Engineering data and tests.
l. Complete nomenclature and number of replacement parts.

3. Performance and design criteria if contractor is delegated design responsibility.
4. Operating standards.
5. Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Schedule for routine cleaning and maintenance.
   e. Repair instructions.
   f. Troubleshooting guide.
   g. Standard printed maintenance instructions and bulletins.
   h. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   i. Identification and nomenclature of parts and components.
   j. List of items recommended to be stocked as spare parts.

6. Maintenance procedures: Include the following information and items that detail essential maintenance procedures:

   a. Test and inspection instructions.
   b. Precautions against improper maintenance.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Aligning, adjusting, and checking instructions.
   e. Demonstration and training videotape, if available.

7. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

   a. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   b. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

8. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
9. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
10. Warranties and bonds, Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

a. Include procedures to follow and required notifications for warranty claims.

## 2.5 SYSTEMS MANUAL

A. The Systems Manual will be authored by the CxA during the Construction Phase of the project. Contractor shall provide the following content for the System Manual in the template provided by the CxA:

a. Emergency Shutdown procedures
b. Startup procedures.
c. Equipment or system break-in procedures.
d. Routine and normal operating instructions.
e. Regulation and control procedures.
f. Instructions on stopping.
g. Normal shutdown instructions.
h. Seasonal and weekend operating instructions.
i. Required sequences for electric or electronic systems.
j. Special operating instructions and procedures.

2. Operating logs.
3. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Provide charts of valve-tag numbers, with the location and function of each valve.

# PART 3 - EXECUTION

## 3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to operation, and maintenance manuals.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Project Officer's operating personnel.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals. If Record drawings must be used, copies are to be included in the manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

F. Comply with Division 01 Section "Closeout Procedures" for the schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

# SECTION 018200 - DEMONSTRATION AND TRAINING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for instructing NIH operation and maintenance personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

B. This specification section is related to any and all specification sections with explicit or implicit reference to demonstration and training including but not limited to the following specification sections:

1. Division 01 Section "Summary"
2. Division 01 Section "Project Management and Coordination"
3. Division 01 Section "Construction Progress Documentation"
4. Division 01 Section "Photographic Documentation"
5. Division 01 Section "Quality Requirements"
6. Division 01 Section "Construction Quality Control"
7. Division 01 Section "Safety and Health"
8. Division 01 Section "Closeout Procedures"

### 1.3 SUBMITTALS

A. Instruction Program/Training Plan: Two months prior to scheduled beginning of the Instruction Program submit electronically the Training Plan specified in Division 01 Section “General Commissioning Requirements” to the Project Officer. Including training modules to be included, a schedule of proposed dates, times, length of instruction time, instructors' names for each training module, and learning objective and outline for each training module.

1. At completion of training, submit 2 hard copy complete training manuals and one electronic copy in fully text searchable PDF format for NIH use.

B. Training Modules. Submit 2 draft copies to the Project Officer of training modules as described in this section 14 calendar days prior to the start of training.

1. NIH will provide review comments within 7 calendar days of receipt of the draft module.
2. All draft modules are to be submitted to the Project Officer prior to Final Inspection.

C. Qualification Data: For facilitator and instructors, to demonstrate their capabilities and experience, include lists of completed projects with project names and addresses, names and addresses of Design Professionals and owners, and other information specified.

D. Attendance Record: For each training module, submit list of participants and length of instruction time.

E. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test. Also submit results of the attendee's evaluation of the instructional program.

## 1.4 QUALIFICATIONS

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that required for this project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.

1. Instructor shall meet or exceed any specific qualifications or experience requirements indicated in the Division 02-33 technical specification sections for the specific system, subsystem, or equipment that is the subject of the training or demonstration.

## 1.5 PREINSTRUCTION CONFERENCE

A. The Contractor, facilitator, and instructors shall conduct a conference at the project site to review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and other facilities.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

## 1.6 COORDINATION

A. Coordinate instruction schedule with the Project Officer. Be prepared to adjust schedule as required to minimize disrupting NIH operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program module until operation and

maintenance data or manual(s) as required for the equipment in the module have been reviewed and approved by the Contracting Officer.

## PART 2 - PRODUCTS

### 2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Division 2-16 technical specification sections:

B. Training Modules: Develop and submit written learning objective and teaching outlines for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project Record Documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.

c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

C. Training modules can be developed and submitted separately however they must be designed to be compiled into a comprehensive training program. The training program submission will not be complete until the final module has been submitted, reviewed, and approved.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

### 3.2 INSTRUCTION

A. Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and NIH for number of participants, instruction times, and location.

B. Contractor provided Instruction: Engage qualified instructors to instruct NIH personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. The Contracting Officer will furnish the Contractor with the names and positions of NIH participants.

D. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with the Project Officer at least 21 days' in advance.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of the module by use of a written or demonstration performance-based test. Also, distribute then collect and compile all evaluations of the session. Scan these evaluations and include in the final Training Record.

F. Cleanup: Collect and remove used and leftover educational materials. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 018200

# SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. BOD documentations are included by reference for information only.

### 1.2 SUMMARY

A. Section Includes general requirements that apply to implementation of commissioning for the following systems, assemblies or components:

1. Mechanical Systems:

a. Air Handling Units AHU-3, 4A, and 4B
b. Variable Frequency Drives
c. Direct Digital Control (DDC) System, including but not limited to temperature control devices, program loops, system integration, web-interface, dampers, control valves, equipment alarms.

### 1.3 DEFINITIONS

A. BOD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

B. CM: Construction Manager.

C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

D. CxA: Commissioning Authority.

E. SMEs: Subject Matter Experts. Individuals with specific expertise and responsibility in a particular area or field.

F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

## 1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

## 1.5 OWNER'S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

B. Provide the BOD documentation, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

C. Review and approve CxA SMEs personnel resumes that will be responsible for executing the CxA scope of work.

## 1.6 CONTRACTOR'S RESPONSIBILITES

A. Contractors shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Perform commissioning tests at the direction of the CxA.
2. Attend construction phase controls coordination meeting.
3. Attend testing, adjusting and balancing review and coordination meeting.
4. Attend commissioning team meetings.
5. Integrate and coordinate commissioning process activities with construction schedule.
6. Participate in commissioned systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
7. Provide information requested by the CxA for final commissioning documentation.
8. Complete all test documentation for following cGMP "Good Documentation Practices" as defined by the CxA.
9. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
10. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
11. Attend commissioning team meetings held on a variable or as needed basis.

12. Contractors shall respond to commissioning Issues Log items in writing (or electronically) within one (1) week of Issues Log issue date.
13. Contractors shall provide formal written notification of completed commissioning Issues Log items within one (1) week of their completion.
14. Maintain an accurate set of red-line drawings for as-builts.
15. Perform and document static testing of duct, piping and electrical cabling as required by specifications. The CxA shall witness selected testing to verify the method of testing is satisfactorily performed.
16. The Construction Manager shall witness and sign off on all static testing of duct, piping and electrical cabling performed by the contractors.
17. A piping system flush and clean procedure shall be submitted to the CxA for review a minimum of four (4) weeks prior to the execution of flush and clean work. Flush and clean work may not proceed until approved by the engineer of record, CxA and Owner.
18. The Construction Manager shall witness and sign off on all flush and cleaning activities performed by the contractors.
19. The Testing & Balancing Contractor shall provide a sample test report for review by the Commissioning Team four (4) weeks prior to performing work onsite.
20. The Testing & Balancing Contractor shall provide the testing and balancing procedure to the Commissioning Team four (4) weeks prior to the execution of work onsite.
21. Complete commissioning test procedures and checklists with the CxA as Work is completed.
22. Submit test and startup reports to the Owner and CxA as required by project specifications and commissioning checklists. Utilize report templates provided by the CxA to report test results. Alternate templates may be used if reviewed and approved by the CxA.
23. Review and accept commissioning process test procedures provided by the Commissioning Authority.
24. Contractors shall startup and perform system testing prior to executing sequence of operations testing with the CxA to “shakedown” and “troubleshoot” the system of nuisance issues. Applicable to any system with controls.
25. Equipment and systems are expected to be in full compliance with the design intent by the commissioning phase.
26. Contractors are to demonstrate system operation through all modes of operation, alarms, interlocks, power failure, integrated testing to the CxA.
27. Provide re-testing of failed items in the Issues Log that have been resolved.
28. Official Commissioning Functional Test Execution for any specific piece of equipment/system/subsystem shall be scheduled upon the installing contractor/subcontractor notifying the Commissioning Team that such specific piece of equipment/system/subsystem is ready for commissioning.
29. Verify the space is meeting the specified environmental conditions for temperature, humidity and room pressure. Adjust and tune the system (HVAC, BAS, Balancing) as needed to show repeatable results over a (14) day period within the specified ranges.
30. Perform test procedures in the Functional Performance Test plan, Integrated Systems Test plan and the Power Failure/Recovery Test plan. Resolve deficiencies and repeat testing for failed procedures.
31. Support the commissioning agent during the Qualification (IQ/OQ) phase to provide BAS trend data as needed and address any deficiencies that are discovered during the Qualification process.
32. Provide training on all commissioned equipment and systems. All training shall be video-recorded.

1.7 CxA's RESPONSIBILITES

A. Organize and lead the commissioning team.

B. Provide commissioning plan.

C. Convene commissioning team meetings.

D. Provide Project-specific commissioning checklists.

E. Verify the execution of commissioning process activities using random sampling. Verification will include, but is not limited to, equipment submittals, commissioning checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the BOD. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

F. Prepare and maintain the Issues Log.

G. Deficiencies: The CxA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

H. Acceptance: The CxA shall determine and advise the CM and Owner of the date of acceptance for each component and system for start of the warranty period.

I. Training: The CxA shall assist the CM to schedule and coordinate training sessions for the Owner's operations and maintenance staff for each system.

J. Prepare and maintain completed commissioning checklist log.

K. Witness systems, assemblies, equipment, and component startup.

L. Observation of tests: The CxA shall observe and coordinate testing as required to ensure system performance meets the design intent.

M. Documentation of tests: The CxA shall document the results of the verification and performance testing directly and /or ensure that the appropriate technicians document all testing. The CxA shall provide standard forms to be used by all parties for consistency of approach and type of information to be recorded.

N. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

1.8 COORDINATION

A. The CM shall be responsible for furnishing a copy of all construction documents, addenda, change orders, and appropriate approved submittals and shop drawings to the CxA.

B. The CxA shall coordinate directly with each contractor on the project specific to their responsibilities and contractual obligations. If the contractor is a subcontractor to another

contractor, the CxA shall disseminate written information to all responsible parties relative to the nature and extent of the communication.

C. The CxA is primarily responsible to the Owner, and as such, shall regularly apprise the Owner of progress, including pending problems and/or disputes, and shall provide regular status reports on progress with each system. Any potential change in the contractual and/or financial obligations of the Owner (credits, change orders, schedule changes, etc.) shall be identified and quantified as soon as possible.

## 1.9 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, system manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists, prestart and startup checklists for commissioned systems, assemblies, equipment and components to be verified and tested.
4. Test and inspection reports and certificates.
5. Verification of testing, adjusting, and balancing reports.

B. The A/E shall provide the following for review by the CxA:

1. Basis of Design
2. Construction Documents

C. Contractors are to provide the following documentation for review by the CxA:

1. Systems Flushing and Fill Plan
2. Submittals
3. Field Test Reports (pipe, duct, receptacle, NETA)
4. BAS Sensor and EMS Sensor Calibration Reports
5. System / Equipment Startup Reports
6. Test & Balance Reports
7. Training Agenda Review and Coordination
8. Trend Logs (BAS)
9. O&M Manuals
10. As-Built Documents

D. CxA Design Phase Deliverables:

1. RACI Matrix
2. Risk Assessment
3. Design review comments.
4. Commissioning Plan

E. CxA Construction Phase Deliverables:

1. Submittal Review: Cx Agent reviews submittals from commissioning perspective to ensure information is clear, meets specifications and supports the commissioning process.
2. Pre-functional Checklist: Checklist generated and filled out by the CxA verifying the proper installation of a device or piece of equipment.
3. Startup Checklist: The Contractor shall provide and execute the manufacturer's starting procedures, complete the start-Up checklist, energizes the device, equipment or system, verify proper working order and ready for dynamic testing. Checklist and start-up test will indicate systems / equipment are ready for functional performance testing.
4. Functional Performance Test: Detailed and thorough testing protocols of the building systems and interaction with building components and other building systems.
5. Integrated Performance Test (IPT): Test protocol that includes failure mode testing for HVAC systems, system performance verification, control stability verification and documentation of final setpoints.
6. Issue Log: Log identifying the installation or function of a component, equipment or system not in compliance with the Contract Documents, perform properly or is not complying with the design intent. The Cx Agent shall maintain and update list of open items, closed items, and back check items until final resolution is achieved.

1.10 SCHEDULE

A. Start-up and testing of systems may proceed prior to final completion of systems to expedite progress. However, the CxA shall not perform testing and checkout services that are the primary responsibility of the contractor or vendor in advance of their testing and checkout.

B. Problems observed shall be addressed immediately, responsible parties notified, and actions to correct deficiencies coordinated in a timely manner.

C. Contractor schedules and scheduling is the responsibility of the CM. The CxA shall provide commissioning scheduling information to the CM for review and planning activities.

1.11 RELATED WORK

A. Commissioning requires support from the contractors. The commissioning process does not relieve any contractors from their obligations to complete all portions of work in a satisfactory manner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT:

A. All industry-standard test equipment required for performing the specified tests shall be provided by the Contractor responsible for executing the test. Any proprietary vendor-specific test equipment shall be provided by that Contractor, vendor or manufacturer.

B. Test equipment shall be calibrated (NIST traceable) within the last 12 months of the testing date.

C. Contractors are to provide calibration certificates for all test instruments. This includes, but is not limited to: volt-meters, amp-meters, manometers, pressure gauges.

D. Contractors are required to use calibrated instrumentation when conducting specified tests (e.g. voltage, amperage, pressure tests, meggar tests, testing and balancing, loop checks, etc).

E. Any portable or hand-held setup or calibration devices required to initialize the control system shall be made available by the control vendor (at no cost) to the CxA.

F. The CxA's instrumentation shall meet the following standards:

1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
2. Be calibrated at the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument.
3. Be maintained in good repair and operating condition throughout the duration of use on this project.

## PART 3 - EXECUTION

### 3.1 COMMISSIONING PLAN AND SCHEDULE

A. The CxA shall develop and submit a schedule for the commissioning process that is integrated with the construction schedule. Included shall be the required work by all team members (CxA, design team, contractors, and the Owner). This schedule shall include time for test and balance, verification, and functional performance testing.

### 3.2 TEST AND BALANCE

A. Air and water balance and equipment performance verification shall be accomplished by an independent test and balance firm. The CxA shall spot check this work to verify accuracy of results.

### 3.3 CxA CONSTRUCTION PHASE TASKS

A. Equipment / Systems Installation Verification: All systems shall be checked for conformance with the construction documents including that systems are installed as per the construction documents, all devices piping configurations and clearance for maintenance.

B. Functional Performance Test: Functional performance testing shall occur after the contractors have successfully completed startup and pre-functional check lists. All functional performance testing shall be directed and executed by the commissioning agent, hands on manner where possible. Including point-to-point verification, control systems manipulation as required for sequence of operation verification, reviewing of trend logs, BAS system integration to laboratory control systems and all other integrated systems.

## 3.4 VERIFICATION AND FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. CxA personnel experienced in the technical aspects of each system to be commissioned shall develop and document the commissioning procedure to be used. These procedures shall be reviewed by the appropriate NIH representatives and design engineers for technical depth, clarity of documentation and completeness. Special emphasis shall be placed on testing procedures that shall conclusively determine actual system performance and compliance with the design intent.

B. The majority of mechanical equipment requires safety devices to stop and/or prevent equipment operation unless minimum safety standards or conditions are met. These may include adequate oil pressure, proof-of-flow, nonfreezing conditions, maximum static pressure, maximum head pressure, etc. The CxA shall observe the actual performance of safety shutoffs in a real or closely simulated condition of failure as performed by the responsible vendor or Contractor of that system or equipment

C. Systems may include safety devices and components that control a variety of equipment operating as a system. Interlocks may be hard-wired or operate from software. The CxA shall verify operation of these interlocks as performed by the responsible vendor or Contractor of that system or equipment.

D. The CxA shall determine the acceptance procedures for each system within Divisions 23 and 26 disciplines. The acceptance procedures shall incorporate the commissioning standards and successful testing results as referred to throughout these specifications.

1. In, particular, the digital control system Contractor shall have all I/O points individually verified for proper function, calibration, and operation. The CxA shall review proposed testing procedures and report formats, and observe sufficient field testing to confirm that all I/O points have been properly tested.
2. All control sequences of operation strategies, alarm generation and reporting shall also be reviewed and proper operation verified by the CxA as performed by the responsible control system Contractor.
3. The central work station graphics, point assignments, alarm messages, and logging functions shall be verified as performed by the responsible control system Contractor.

E. The appropriate contractor and vendor(s) shall be informed of what tests are to be performed and the expected results. Whereas some test results and interpretations may not become evident until the actual tests are performed, all parties shall have a reasonable understanding of the requirements. The commissioning plan shall address those requirements and be distributed to all parties involved with that particular system.

F. Acceptance procedures shall confirm the performance of systems to the extent of the design intent. When a system is accepted, the Owner shall be assured that the system is complete, works as intended, is correctly documented, and operator training has been performed.

G. Division 23 contractor shall be responsible for performing and documenting all specified tests included in the division 23 specifications, including but not limited to, equipment startup, HEPA filter certification, and duct/pipe leak testing.

H. Division 26 contractor shall be responsible for performing and documenting on test reports all NETA testing, megger checks, grounding checks and receptacle tests. Contractor shall support all power failure testing, oxygen monitor startup/calibration, startup activities and fire alarm tests.

I. Building Automation System Contractor shall support commissioning and qualification testing by demonstrating all sequence of operations, alarms, work station functions, and trend data to prove out stability of system control and ability to maintain environmental parameters within the specified ranges.

J. Testing and Balancing contractor shall support commissioning by demonstrating system is balanced to maintain the specified air change rates and room pressurization through all modes of HVAC system normal operation and emergency modes.

## 3.5 TEST INSTRUMENTS

A. All instruments (including voltmeters, multimeters) used by vendors, contractors, and manufacturer representatives for performing startup and commissioning shall be in current calibration (NIST traceable).

## 3.6 OPERATING AND MAINTENANCE (O&M) MANUALS

A. The CxA shall review the draft form of the O&M manuals provided by the contractors. The review process shall verify that O&M instructions meet specifications and are included for all equipment furnished by the contractor, and that the instructions and wiring diagrams are specific (edited where necessary) to the actual equipment provide for this project.

1. Published literature shall be specifically oriented to the provided equipment and shall indicate required operation and maintenance procedures, parts lists, assembly/disassembly diagrams, and related information.
2. The contractor shall incorporate the standard technical literature into system specific formats for this facility as designed and as actually installed. The resulting O&M information shall be system specific, concise, to the point, and tailored specifically to this facility. The CxA shall review and edit these documents as necessary for final corrections by the contractor.
3. The O&M manual shall be reviewed, edited and finalized prior to Owner training sessions, as these documents are to be utilized in the training sessions.
4. Warranty information shall be included with the O&M by the installing contractor/vendor. Shall include contact information, warranty effective date and terms.
5. All O&M manuals and turnover documentation shall be provided in searchable and book-marked Protected Document Format (PDF).

## 3.7 TRAINING

A. The appropriate installing contractors shall provide training on all the major systems per specifications, including peculiarities specific to this project.

1. Training shall be provided per project specifications including but not limited to include all new equipment and BAS control system. A walk-through by each contractor shall be provided to train owner staff on location of devices, accessibility, valves, dampers and equipment.
2. Training Plan: Contractors shall submit a Training Plan Agenda for Owner and Cx Agent approval. The Training Plan shall summarize all equipment and systems-related training events with topics to be covered and approximate training dura
3. tion, outline both the Equipment and Systems Training and Final Systems Operation Training Events. All training shall be project specific.
4. All training shall be video recorded by the CM.

## 3.8 CONTRACTOR TURNOVER PACKAGES

A. All turnover package documentation (record drawings, O&Ms, warranty docs, etc) shall be provided by the CM or sub-contractors / vendors in electronic format to Owner and CxA.

1. O & M Documentation: Contractor shall provide operation and maintenance documentation for all equipment and systems. This shall be provided in searchable PDF format (Refer to Division 1 – General Requirements).
2. As-Built Drawings: Contractors shall provide As-Built documentation illustrating all changes from original design (Refer to Division 1 – General Requirements).
3. Nameplate Data: Nameplate date shall be collected as required in the construction documents (Refer to Division 1 – General Requirements).
4. Warranty: CM is to provide a Warranty Log detailing equipment and systems covered under warranty. The Warranty Log must have equipment tag, manufacturer, model, serial #, contact information for service calls, warranty start date and duration. At the start of the Warranty, contractors are responsible for servicing the equipment and responding to warranty calls (Refer to Division 1 – General Requirements). Generally the logistics of how this work is initiated will be part of the management protocols discussed during the Construction Phase Kick off meeting.

## 3.9 CxA CLOSEOUT DOCUMENT DELIVERABLES

A. Commissioning Report: Report shall include Executive summary, Cx analysis, open and closed action item report list, completed pre-functional checklist, startup test, functional performance test results, Cx meeting minutes, trend log reviews, blackout test script and results.

B. Systems Manual: Systems manual shall include brief description of systems commissioned including Retro / Continuous commissioning test

## 3.10 RECORD DRAWINGS

A. The CxA shall review the as-built contract documents to verify incorporation of both design changes and as-built construction details. Discrepancies noted shall be corrected by the appropriate party.

3.11 EXCLUSIONS

A. The CxA is not responsible for construction means, methods, job safety, or any CM functions on the job site.

B. The Contractors shall provide all services requiring tools or the use of tools to start-up, test, adjust, or otherwise bring equipment and systems into a fully operational state. The CxA shall assist the CM to coordinate and observe these procedures (and may make minor adjustments), but shall not perform construction or technician services other than verification of testing, adjusting, balancing, and control functions.

END OF SECTION 019113

# PART 1 - GENERAL

## 1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.

## 1.2 DEFINITIONS

A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

## 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
1. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).

a. Location of construction joints is subject to approval of COTR.

## 1.5 INFORMATIONAL SUBMITTALS

A. Research Reports: For insulating concrete forms indicating compliance with ICC's Acceptance Criteria AC353.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

D. Qualification Statements: For testing and inspection agency.

## 1.6 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

# PART 2 - PRODUCTS

## 2.1 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:

    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

        1) APA HDO (high-density overlay).
        2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
        3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
        4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

## 2.2 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners to be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

G. Sealant: One-part moisture cure silicone sealant used with form liners.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301 (ACI 301M).

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 (ACI 117M) Class D, 1 inch (25 mm).
2. Surface Finish-2.0: ACI 117 (ACI 117M) Class B, 1/4 inch (6 mm).
3. Surface Finish-3.0: ACI 117 (ACI 117M) Class A, 1/8 inch (3.0 mm).

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of COTR prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by COTR.
3. Place joints perpendicular to main reinforcement.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

M. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

N. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

O. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

## 3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

## 3.3 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

D. Prepare test and inspection reports.

END OF SECTION 031000

# SECTION 032000 - CONCRETE REINFORCING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

### 1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

### 1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of COTR.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement.

D. Field quality-control reports.

E. Minutes of preinstallation conference.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage and to avoid damaging coatings on steel reinforcement.

1. Store reinforcement to avoid contact with earth.

# PART 2 - PRODUCTS

## 2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

## 2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch (25 mm), not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318 (ACI 318M).

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
2. Stagger splices in accordance with ACI 318 (ACI 318M).

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

    a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches (305 mm).

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

## 3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by COTR.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

## 3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117 (ACI 117M).

## 3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 032000

# SECTION 033000 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Vapor retarders.
5. Floor and slab treatments.
6. Liquid floor treatments.
7. Curing materials.
8. Accessories.
9. Repair materials.
10. Concrete mixture materials.
11. Concrete mixture class types.
12. Concrete mixing.

### 1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.
e. Special concrete finish Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Cold- and hot-weather concreting procedures.
f. Concrete finishes and finishing.
g. Curing procedures.
h. Forms and form-removal limitations.
i. Methods for achieving specified floor and slab flatness and levelness.
j. Floor and slab flatness and levelness measurements.
k. Concrete repair procedures.
l. Concrete protection.
m. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
n. Protection of field cured field test cylinders.
o. Distribution of test reports.

## 1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral fillers.
10. Admixtures:

    a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.

11. Color pigments.
12. Fiber reinforcement.
13. Vapor retarders.
14. Floor and slab treatments.
15. Liquid floor treatments.
16. Curing materials.

    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

17. Joint fillers.
18. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Steel-fiber reinforcement content.
11. Synthetic microfiber content.
12. Synthetic macrofiber content.
13. Intended placement method.
14. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

    a. Location of construction joints is subject to approval of the COTR.

D. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.
5. Final finish for floors.
6. Floor treatment, if any.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.

7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral filler.
10. Admixtures.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with ASTM E1155 (ASTM E1155M).

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/Engineer.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.

D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

## 1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Evaluation of permeability-reducing admixtures.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301 (ACI 301M).

## 1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 (ACI 301M) as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below 40 deg F (4.4 deg C) during the protection period, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F (1.7 deg C), other than reinforcing steel.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F (35 deg C).
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## 1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless modified by requirements in the Contract Documents.

## 2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/Type II.
2. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.
3. Pozzolans: ASTM C618, Class C, F, or N.
4. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
5. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.
6. Silica Fume: ASTM C1240.

C. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, Class 3S.
2. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) nominal.
3. Fine Aggregate: ASTM C33/C33M.

4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with one of the following for each aggregate used:

    a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
    b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
    c. Alkali Content in Concrete: Not to exceed 4 lb./cu. yd. (2.37 kg/cu. m) for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or 3 lb./cu. yd. (1.78 kg/cu. m) for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with ACI 301 (ACI 301M). Do not use this option with natural pozzolan or fly ash that has a calcium oxide content greater than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at one year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

D. Ground Calcium Carbonate or Aggregate Mineral Filler: ASTM C1797. Unless otherwise permitted, do not use mineral filler derived from carbonate sources in concrete for members assigned to Exposure Class S1, S2, or S3.

## 2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.
7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

8. Moisture-Vapor-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, moisture-vapor-reducing, capable of reducing water absorption in and moisture-vapor emission from concrete (MVRA).

C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602/C1602M.

## 2.4 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class C: ASTM E1745, Class C, not less than 10 mils (0.25 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

## 2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: 8 ft. (2438 mm) wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

## 2.6 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.7 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.

## 2.8 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for equipment pads.

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Maximum w/cm Ratio: 0.50.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm) for concrete.
4. Slump Flow Limit: 22 inches (550 mm), plus or minus 1-1/2 inches (40 mm).

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.

2. Do not proceed until unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

## 3.3 TOLERANCES

A. Comply with ACI 117 (ACI 117M).

## 3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

## 3.5 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches (150 mm), sealing vapor retarder to concrete.
4. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches (150 mm) on all sides and sealing to vapor retarder.

## 3.6 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify COTR and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301 (ACI 301M).

    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

## 3.7 APPLICATION OF FINISHING FLOORS AND SLABS

A. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

## 3.8 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 (ACI 301M) for cold weather protection during curing.
2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h (1 kg/sq. m x h), calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

        1) Recoat areas subject to heavy rainfall within three hours after initial application.
        2) Maintain continuity of coating and repair damage during curing period.

## 3.9 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301 (ACI 301M), including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
        13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94/C94M.

D. Inspections:
1. Verification of use of required design mixture.
2. Concrete placement, including conveying and depositing.
3. Curing procedures and maintenance of curing temperature.
4. Verification of concrete strength before removal of shores and forms from beams and slabs.
5. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 150 cu. yd. (114 cu. m) or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

    a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests as needed.

3. Slump Flow: ASTM C1611/C1611M:

    a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests as needed.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;.

    a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:

    a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample when strength test specimens are cast.

6. Concrete Density: ASTM C138/C138M:

    a. One test for each composite sample when strength test specimens are cast.

7. Compression Test Specimens: ASTM C31/C31M:

    a. Cast and standard cure two sets of two 6 inches (150 mm) by 12-inches (300 mm) or 4-inch (100-mm) by 8-inch (200-mm) cylindrical specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C39/C39M.

    a. Test one set of two standard cured specimens at seven days and one set of two specimens at 28 days.

9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than

10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

        1) Acceptance criteria for concrete strength to be in accordance with ACI 301 (ACI 301M), Section 1.7.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

## 3.10 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

# SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

### 1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

## PART 2 - PRODUCTS

### 2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

### 2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## 2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION - Not Applicable

END OF SECTION 230513

# SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Advance Products & Systems, Inc.
2. Airex Manufacturing.
3. CALPICO, Inc.
4. GPT; an EnPro Industries company.
5. Metraflex Company.
6. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company
5. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials.

## 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

## 3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

## 3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

1 Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

1 Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

1 Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

1 Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

# SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

## PART 2 - PRODUCTS

### 2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

### 2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

# SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Trerice, H. O. Co.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ametek U.S. Gauge.
    b. Trerice, H. O. Co.

c. Watts; a Watts Water Technologies company.
d. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/2, ASME B1.20.1 pipe threads.

## 2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements - provide products by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company.
8. Weiss Instruments, Inc.
9. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

## 2.6 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company.
8. Weiss Instruments, Inc.

B. Furnish one test-plug kit containing one thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.7 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARCHON Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Rosemount Division.
4. Ernst Flow Industries.
5. John C. Ernst Co., Inc.
6. KOBOLD Instruments, Inc. - USA.
7. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.
8. Pentair Valves & Controls; Penberthy Brand.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids except steam.

H. Install test plugs in piping tees.

I. Install flow indicators in piping systems in accessible positions for easy viewing.

J. Install permanent indicators on walls or brackets in accessible and readable positions.

K. Install connection fittings in accessible locations for attachment to portable indicators.

L. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Two inlets and two outlets of each chiller.
3. Inlet and outlet of each hydronic coil in air-handling units.

M. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

## 3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

## 3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

## 3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each chiller shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with EPDM self-sealing rubber inserts.

D. Thermometer stems shall be of length to match thermowell insertion length.

## 3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F.

B. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each chiller chilled-water connection shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 30-in. Hg to 15 psi.

B. Scale Range for Heating, Hot-Water Piping: 30-in. Hg to 15 psi.

END OF SECTION 230519

# SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron, single-flange butterfly valves.
5. Bronze swing check valves.
6. Iron, center-guided check valves.
7. Bronze gate valves.
8. Bronze glove valves.
9. Chainwheels.

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

### 1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. HWP: Hot working pressure.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

## 1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

# PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Steam control valve shall have a stainless steel trim.

## 2.2 BRONZE ANGLE VALVES

A. Class 150, Bronze Angle Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Stockham Division.
b. Kitz Corporation.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: bronze.

## 2.3 BRASS BALL VALVES

A. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jomar International, LTD.
b. Kitz Corporation.
c. Red-White Valve Corporation.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. HWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

## 2.4 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. DynaQuip Controls.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corporation.

2. Description:

a. Standard: MSS SP-110.
b. HWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

## 2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Bray Controls; a division of Bray International.
c. Conbraco Industries, Inc.; Apollo Valves.

d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. DeZurik Water Controls.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Norriseal; a Dover Corporation company.
m. Red-White Valve Corporation.
n. Spence Strainers International; a division of CIRCOR International.
o. Tyco Valves & Controls; a unit of Tyco Flow Control.
p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

## 2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

## 2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. APCO Willamette Valve and Primer Corporation.
   b. Crispin Valve.
   c. Val-Matic Valve & Manufacturing Corp.

2. Description:

   a. Standard: MSS SP-125.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
   c. NPS 14 to NPS 24, CWP Rating: 250 psig.
   d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
   e. Style: Compact wafer.
   f. Seat: EPDM.

## 2.8 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Powell Valves.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   i. Zy-Tech Global Industries, Inc.

2. Description:

   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
   h. Handwheel: bronze.

2.9 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries. Retain option in "Description" Paragraph below if chainwheel does not mount directly to the valve stem or gearbox shaft.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

## 3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

## 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Gate valves.
2. Butterfly Valve Dead-End Service: Single-flange type.
3. Throttling Service: Butterfly valves.
4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified HWP classes or CWP ratings are not available, the same types of valves with higher HWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

## 3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Three piece, full port, bronze trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Gate Valves: Class 150, NRS bronze.
6. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, bronze disc.
4. Iron Swing Check Valves: Class 250, metal seats.
5. Iron, Center-Guided Check Valves: Class 150, metal seat.
6. Iron Gate Valves: Class 250, NRS.
7. Iron Globe Valves: Class 250.
8. Lubricated Plug Valves: threaded flanged.
9. Eccentric Plug Valves: 175 CWP, resilient seating.

## 3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves Class 150, bronze disc.
3. Ball Valves: Three piece, full port, brass or bronze trim.
4. Bronze Swing Check Valves: Class 125, bronze.
5. Bronze Gate Valves: Class 150, NRS.
6. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 150 CWP, EPDM seat, aluminum-bronze disc.
4. Iron Swing Check Valves: Class 250, metal seats.
5. Iron, Center-Guided Check Valves: Class 150, metal seat.
6. Iron Gate Valves: Class 250, NRS.
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 250.

END OF SECTION 230523

# SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Thermal-hanger shield inserts.
6. Fastener systems.
7. Pipe stands.
8. Equipment supports.

B. Related Sections:

1. Section 233113 "Metal Ducts" for duct hangers and supports.

### 1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

### 1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.

c. Flex-Strut Inc.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut Corporation; Tyco International, Ltd.
g. Wesanco, Inc.

3. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Standard: MFMA-4.
5. Channels: Continuous slotted steel channel with inturned lips.
6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Elec Hot-dipped galvanized.
9. Paint Coating: Vinyl <Insert paint type>.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Empire Industries, Inc.
c. ERICO International Corporation.
d. Haydon Corporation; H-Strut Division.
e. NIBCO INC.
f. PHD Manufacturing, Inc.
g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

## 2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.

9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

# PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers MSS Type 1: For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps MSS Type 2: For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps MSS Type 3: For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps MSS Type 4: For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers MSS Type 5: For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers MSS Type 6: For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers MSS Type 7: For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers MSS Type 9: For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers MSS Type 10: For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers MSS Type 11: For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps MSS Type 12: For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts MSS Type 24: For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips MSS Type 26: For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports MSS Type 36: For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles MSS Type 37: For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports MSS Type 38: For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls MSS Type 41 For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers MSS Type 43: For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls MSS Type 44: For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units MSS Type 45: For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units MSS Type 46: For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps MSS Type 8: For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps MSS Type 42: For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles MSS Type 13: For adjustment up to 6 inches or heavy loads.
2. Steel Clevises MSS Type 14: For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles MSS Type 15: For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets MSS Type 16: For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts MSS Type 17: For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts MSS Type 18: For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps MSS Type 19: For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps MSS Type 20: For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps MSS Type 21: For attaching to center of bottom flange of beams.
5. Welded Beam Attachments MSS Type 22: For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps MSS Type 23: For structural shapes.
7. Top-Beam Clamps MSS Type 25: For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps MSS Type 27: For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts MSS Type 28: For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts MSS Type 29: For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces MSS Type 30: For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light MSS Type 31: 750 lb.
    b. Medium MSS Type 32: 1500 lb.
    c. Heavy MSS Type 33: 3000 lb.

13. Side-Beam Brackets MSS Type 34: For sides of steel or wooden beams.
14. Plate Lugs MSS Type 57: For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers MSS Type 58: For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles MSS Type 39: To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields MSS Type 40: Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices MSS Type 47: Where indicated to control piping movement.
2. Spring Cushions MSS Type 48: For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers MSS Type 49: For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces MSS Type 50: To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers MSS Type 51: Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports MSS Type 52: Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers MSS Type 53: Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal MSS Type 54: Mounted horizontally.
    b. Vertical MSS Type 55: Mounted vertically.
    c. Trapeze MSS Type 56: Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION 230529

# SECTION 230548 - VIBRATION CONTROLS FOR HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Housed-spring isolators.
4. Pipe-riser resilient supports.
5. Spring hangers.
6. Snubbers.
7. Mechanical anchor bolts.
8. Adhesive anchor bolts.
9. Vibration isolation equipment bases.

### 1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning & Development.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device required.

    a. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 125 mph
2. Building Classification Category: IV.
3. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

## 2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.

b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Novia; A Division of C&P.
g. Vibration Eliminator Co., Inc.
h. Vibration Isolation.
i. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.

a. Surface Pattern: Smooth pattern.
b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Novia; A Division of C&P.
g. Vibration Eliminator Co., Inc.
h. Vibration Isolation.
i. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top housing with attachment and leveling bolt.

## 2.5 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

## 2.6 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.

c. Kinetics Noise Control, Inc.
d. Mason Industries, Inc.
e. Novia; A Division of C&P.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.7 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Novia; A Division of C&P.
4. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
2. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

## 2.8 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.9 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.10 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. California Dynamics Corporation.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. Novia; A Division of C&P.
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation.
7. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods.

C. Strength of Support: Where not indicated, select sizes of components so strength is adequate to carry present and future static loads within specified loading limits.

## 3.3 VIBRATION CONTROL INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component unless post connection testing has been approved, and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

## 3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

## 3.6 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION 230548

# SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.

3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated plans, details, and schedules, and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated in plans, details, and schedules and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

## 2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

## 2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

## 2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation as shown on valve tag, location of valve room or space, normal-operating position open, closed, or modulating, and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.7 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.
2. Heating Water Piping: White letters on a safety-green background.
3. Refrigerant Piping: White letters on a safety-purple background.

## 3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

## 3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Chilled Water: 1-1/2 inches, round.
b. Refrigerant: 1-1/2 inches, round Insert shape.
c. Hot Water: 1-1/2 inches, round.
d. Gas: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
b. Flammable Fluids: Black letters on a safety-yellow background.
c. Combustible Fluids: White letters on a safety-brown background.
d. Potable and Other Water: White letters on a safety-green background.
e. Compressed Air: White letters on a safety-blue background.

f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

## 3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

# SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

### 1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 15 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.

B. TAB Conference: Meet with Architect, Owner and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect, Owner and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment

performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine two-way valves and three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation" and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound units.

## 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

## 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point

airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

## 3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

## 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

D. Verify that memory stops have been set.

## 3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

## 3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

## 3.11 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.
3. Heating-Water Flow Rate: Plus or minus 5 percent.
4. Cooling-Water Flow Rate: Plus or minus 5 percent.

## 3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.

8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data - Indicated and Actual Values:

    a. Total air flow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.
    g. Cooling-coil static-pressure differential in inches wg.
    h. Heating-coil static-pressure differential in inches wg.
    i. Outdoor airflow in cfm.
    j. Return airflow in cfm.
    k. Outdoor-air damper position.
    l. Return-air damper position.
    m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.
    d. Number of rows.
    e. Fin spacing in fins per inch o.c.
    f. Make and model number.
    g. Face area in sq. ft.
    h. Tube size in NPS.
    i. Tube and fin materials.
    j. Circuiting arrangement.

2. Test Data - Indicated and Actual Values:

    a. Air flow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.
    i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data - Indicated and Actual Values:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data - Indicated and Actual Values:

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data - Indicated and Actual Values:

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.

e. Dates of calibration.

## 3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

## 3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

# SECTION 230713 - DUCT INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."
2. Section 233113 "Metal Ducts" for duct liners.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

## 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity k-value at 100 deg Fis 0.29 Btu x in./h x sq. ft. x deg For less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 1-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.

## 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 permat 43-mildry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
2. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

## 2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide the following:

a. Polyguard Products, Inc.; Alumaguard 60.

## 2.9 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inchin width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inchin width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## 2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide the following:

      1 AGM Industries, Inc.; CWP-1.
      2 GEMCO; CD.
      3 Midwest Fasteners, Inc.; CD.
      4 Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inchgalvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, provide the following:

      1 AGM Industries, Inc.; CHP-1.

2 GEMCO; Cupped Head Weld Pin.
3 Midwest Fasteners, Inc.; Cupped Head.
4 Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide the following:

      1 AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2 GEMCO; Perforated Base.
      3 Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide the following:

      1 AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2 GEMCO; Peel & Press.
      3 Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, provide the following:

      1 AGM Industries, Inc.; RC-150.
      2 GEMCO; R-150.
      3 Midwest Fasteners, Inc.; WA-150.
      4 Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

## 3.4 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg Fat 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

## 3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

## 3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies.

## 3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

## 3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Outdoor, concealed supply and outdoor air.
4. Outdoor, exposed supply and outdoor air.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

## 3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

B. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

C. Concealed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

D. Concealed, supply-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

E. Concealed, outdoor-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

F. Exposed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

G. Exposed, supply-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

## 3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, Rectangular, Supply-Air Duct Insulation: Mineral-fiber board.

B. Exposed, Rectangular, Return-Air Duct Insulation: Mineral-fiber board.

C. Exposed, Supply-Air Plenum Insulation: Mineral-fiber board.

## 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.
2. Stainless Steel, Type 304: 0.010 inch thick.

D. Ducts and Plenums, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

## 3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. Aluminum, Smooth: 0.016 inch thick.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 230713

# SECTION 230719 - HVAC PIPING INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Chilled-water piping, indoors and outdoors.
3. Heating hot-water piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Knauf Insulation.
c. Manson Insulation Inc.
d. Owens Corning.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

## 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

## 2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller Construction Products.
b. Knauf Insulation.
c. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Vimasco Corporation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

## 2.6 SEALANTS

A. Cellular-Glass, Phenolic, and Polyisocyanurate Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.
e. Pittsburgh Corning Corporation.

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

## 2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
3. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

## 2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alpha Associates, Inc.

## 2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. ITW Insulation Systems; Illinois Tool Works, Inc.
   c. RPR Products, Inc.

D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Polyguard Products, Inc.

## 2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. Compac Corporation.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.
   e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corporation.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.
    e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.

2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

## 2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. RPR Products, Inc.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a stainless steel jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

## 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

## 3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

## 3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

## 3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Chilled Water, above 40 Deg F:

1. NPS 12 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Pipe Insulation Wicking System: 2 inches thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 12 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. Stainless Steel, Type 304, Smooth 2B Finish: 0.024 inch thick.

D. Piping, Exposed:

1. Stainless Steel, Type 304, Smooth 2B Finish, Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 230719

# SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

### 1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

### 1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

### 1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

G. Acceptance Phase

1. Assist CxA in Functional Performance Testing. Assistance will typically include the following:

a. Manipulate systems and equipment to facilitate Functional Performance Testing.
b. Provide any specialized instrumentation necessary for Functional Performance Testing.
c. Manipulate BAS and other control systems to facilitate Functional Performance Testing.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.

8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Contractor shall use the same instruments by model and serial number that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing,

adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

## 3.3 GENERAL TESTING REQUIREMENTS

A. All Division 23 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices (sensors, valves, etc.) that make up these systems are included,

1. AHUs
2. Air Terminal Units.
3. Building Automation System.

B. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

C. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation, refrigeration and domestic cold and hot water through distribution systems to each space. Testing shall include measuring capacities and effectiveness of operational and control functions.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

F. Tests will be performed using design conditions whenever possible.

G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

H. The CxA may direct that set points be altered when simulating conditions is not practical.

I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

J. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

A. AIR TERMINAL UNITS

1. Start-Up Checks: Perform the following inspections/checks during start-up:

a. After construction is completed, including painting if applicable, clean unit exposed surfaces.
b. Vacuum-clean terminal coils and inside of cabinets.
c. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
d. Verify adequate access for maintenance.
e. Check power and control voltages.
f. Check rotation of fan where applicable.
g. Check calibration and operation of the controlling elements.
h. Check control valves for required close-off and fail position.
i. Install new filter units for terminals requiring same.

B. AIR-HANDLING UNITS

1. Start-Up Checks: Perform the following inspections/checks during start-up:

a. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
b. Cleaning: Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
c. Adjust and lubricate dampers and linkages for proper damper operation.
d. For field fabricated units, ensure the sections are properly connected within acceptable tolerances.
e. Seal all penetrations to be air-tight and ensure access doors seat tightly.
f. Verify that unit is secure on mountings and supporting devices and connections for piping, ductwork, and electrical are complete.
g. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
h. Ensure vibration isolation integrity is maintained throughout the AHU installation and its connections.
i. Tension all belts per the drive manufacturer’s recommendations.
j. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
k. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
l. Comb coil fins for parallel orientation.
m. Install clean filters.
n. Ensure condensate drains properly and that trap is adequate.
o. Stroke all valves and damper to ensure free and full travel.

2. Start-Up Tests: Perform the following during start-up:

a. Pressure test units as required in the AHU specification.

C. FANS

1. Start-Up Checks: Perform the following inspections/checks during start-up:

   a. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
   b. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
   c. Adjust and lubricate dampers and linkages for proper damper operation.
   d. Verify that unit is secure on mountings and supporting devices and connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
   e. Ensure vibration isolation integrity is maintained with the fan installation and associated connections.
   f. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
   g. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
   h. Stroke all dampers to ensure free and full travel.

2. Training: Contractor shall train Owner's maintenance personnel including:

   a. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
   b. Familiarization with contents of manufacturer’s Operating and Maintenance Manuals.

D. BUILDING AUTOMATION SYSTEM AND CONTROL SYSTEMS

1. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230923 "Direct Digital Control - DDC System for HVAC". Assist the CxA with preparation of testing plans. This requires manufacturers authorized representative to start-up, test, adjust, and calibrate direct digital and other microprocessor-based control systems and demonstrate compliance with requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

E. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation.

END OF SECTION 230800

# SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
3. Raceways:

    a. Section 260533 "Raceways and Boxes for Electrical Systems" for raceways for low-voltage control cable.

### 1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

J. DOCSIS: Data-Over Cable Service Interface Specifications.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. LAN: Local area network.

O. LNS: LonWorks Network Services.

P. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.

9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

Q. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

R. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

S. Modbus TCP/IP: An open protocol for exchange of process data.

T. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

W. Peer to Peer: Networking architecture that treats all network stations as equal partners.

X. POT: Portable operator's terminal.

Y. RAM: Random access memory.

Z. RF: Radio frequency.

AA. Router: Device connecting two or more networks at network layer.

BB. TCP/IP: Transport control protocol/Internet protocol.

CC. UPS: Uninterruptible power supply.

DD. USB: Universal Serial Bus.

EE. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

FF. VAV: Variable air volume.

GG. WLED: White light emitting diode.

## 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

    a. DDC controllers.
    b. Enclosures.
    c. Electrical power devices.
    d. UPS units.
    e. Accessories.
    f. Instruments.
    g. Control dampers and actuators.
    h. Control valves and actuators.

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

B. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. Sustainable Design Submittals:

1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details where applicable.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail means of vibration isolation and show attachments to rotating equipment.
4. Plan Drawings indicating the following:

    a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
    d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    e. Network communication cable and raceway routing.

f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

5. Schematic drawings for each controlled HVAC system indicating the following:

a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
c. A graphic showing location of control I/O in proper relationship to HVAC system.
d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
g. Narrative sequence of operation.
h. Graphic sequence of operation, showing all inputs and output logical blocks.

6. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
c. Front, rear, and side elevations and nameplate legend.
d. Unique drawing for each panel.

7. DDC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in DDC system.
c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

8. DDC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

9. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches and transmitters.
d. Process signal tubing to sensors, switches and transmitters.

10. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
c. Intended operator access between related hierarchical display screens.

E. System Description:

1. The controls shall be LonWorks based with LonMark certified controllers with peer-to-peer communication LonTalk bus.
2. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
3. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
4. System and product operation under each potential failure condition including, but not limited to, the following:

a. Loss of power.
b. Loss of network communication signal.
c. Loss of controller signals to inputs and outpoints.
d. Operator workstation failure.
e. Gateway failure.
f. Network failure
g. Controller failure.
h. Instrument failure.
i. Control damper and valve actuator failure.

5. Complete bibliography of documentation and media to be delivered to Owner.
6. Description of testing plans and procedures.
7. Description of Owner training.

F. Samples:

1. For each exposed product, installed in finished space for approval of selection of aesthetic characteristics.

G. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.

a. Flow at Project design and minimum flow conditions.
b. Face velocity at Project design and minimum airflow conditions.
c. Pressure drop across damper at Project design and minimum airflow conditions.
d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
e. Maximum close-off pressure.
f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

a. Flow at Project design and minimum flow conditions.
b. Pressure-differential drop across valve at Project design flow condition.
c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

a. Instrument flow range.
b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
d. Pressure-differential loss across instrument at Project design flow conditions.
e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings, reflected ceiling plan(s), and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Qualification Data:

1. Systems Provider Qualification Data:

a. Resume of project manager assigned to Project.
b. Resumes of application engineering staff assigned to Project.

c. Resumes of installation and programming technicians assigned to Project.
d. Resumes of service technicians assigned to Project.
e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
h. Owner contact information for past project including name, phone number, and e-mail address.
i. Contractor contact information for past project including name, phone number, and e-mail address.
j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.

2. Manufacturer's qualification data.
3. Testing agency's qualifications data.

C. Welding certificates.

D. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
2. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks.

E. Product Test Reports: For each product that requires testing to be performed by a qualified testing agency.

F. Preconstruction Test Reports: For each separate test performed.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For manufacturer's warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.

b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:

    1) Design and install new points, panels, and other hardware.
    2) Perform preventive maintenance and calibration.
    3) Debug hardware problems.
    4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.

C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during two-year period following warranty period.

D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Network Controller: One.
2. Programmable Application Controller: One.

3. Application-Specific Controller: One.
4. Room Carbon Dioxide Sensor and Transmitter: One.
5. Room Temperature Sensor and Transmitter: One.
6. General-Purpose Relay: One.
7. Multifunction Time-Delay Relay: One.
8. Latching Relay: One.
9. Current-Sensing Relay: One.
10. Combination On-Off Status Sensor and On-Off Relay: One.
11. Transformer: One.
12. DC Power Supply: One.
13. Supply of 20 percent spare optical fiber cable splice organizer cabinets for several re-terminations.

## 1.8 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing and quality control.
    d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
    e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
3. Demonstrated past experience on five projects of similar complexity, scope and value.
4. Each person assigned to Project shall have demonstrated past experience.
5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
8. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## 1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.

1. Include test assemblies representative of proposed materials and construction.
2. Build mockup at testing agency facility using personnel, materials, and methods of construction that will be used at Project site.
3. Notify Architect seven days in advance of dates and times of tests.

B. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

## 1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

a. Install updates only after receiving Owner's written authorization.

3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
4. Warranty Period: Two year(s) from date of Substantial Completion.

a. For Gateway: Three-year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automated Logic Corporation.
2. Honeywell International Inc.
3. TAC.
4. Siemens Industry, Inc., Building Technologies Division.
5. Trane.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system shall be web based.

1. Web-Based Access to DDC System:

a. DDC system software shall be based on server thin-client architecture, designed around open standards of web technology. DDC system server shall be accessed using a web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.
b. Intent of thin-client architecture is to provide operators complete access to DDC system via a web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
c. Web access shall be password protected.

2. Web-Compatible Access to DDC System:

a. Workstation and server shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.

b. DDC system shall support web browser access to building data. Operator using a standard web browser shall be able to access control graphics and change adjustable set points.
c. Web access shall be password protected.

## 2.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system shall manage HVAC systems.
b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system shall operate while unattended by an operator and through operator interaction.
e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.

B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. DDC System Speed:

1. Response Time of Connected I/O:

a. AI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
b. BI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
c. AO points connected to DDC system shall begin to respond to controller output commands within one second(s). Global commands shall also comply with this requirement.
d. BO point values connected to DDC system shall respond to controller output commands within one second(s). Global commands shall also comply with this requirement.

2. Display of Connected I/O:

a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.

b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
d. Graphic display refresh shall update within four seconds.
e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

E. DDC System Data Storage:

1. Include capability to archive not less than 60 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
2. Local Storage:

a. Provide workstation with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:

a. Provide application-based and web browser interfaces to configure, upload, download, and manage data, and service plan with storage adequate to store all data for term indicated. Cloud storage shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

F. DDC Data Access:

1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

G. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least four times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

H. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

    a. Thermal: Within 1 percent of reading.
    b. Electric Power: Within 1 percent of reading.
    c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

    a. Air: Within 2 percent of design flow rate.
    b. Air (Terminal Units): Within 5 percent of design flow rate.
    c. Water: Within 2 percent of design flow rate.

3. Gas:

    a. Carbon Dioxide: Within 50 ppm.
    b. Refrigerant: Within 50 ppm.

4. Moisture (Relative Humidity):

    a. Air: Within 2 percent RH.
    b. Outdoor: Within 2 percent RH.

5. Level: Within 2 percent of reading.
6. Pressure:

    a. Air, Ducts and Equipment: 0.5 percent of instrument range.
    b. Water: Within 0.25 percent of instrument range.

7. Speed: Within 5 percent of reading.
8. Temperature, Dew Point:

    a. Air: Within 0.5 deg F.
    b. Space: Within 0.5 deg F.
    c. Outdoor: Within 2 deg F.

9. Temperature, Dry Bulb:

    a. Air: Within 0.5 deg F.
    b. Space: Within 0.5 deg F.
    c. Outdoor: Within 1 deg F.
    d. Chilled Water: Within 0.5 deg F.
    e. Heating Hot Water: Within 0.5 deg F.
    f. Temperature Difference: Within 0.25 deg F.

10. Temperature, Wet Bulb:

    a. Air: Within 0.5 deg F.

b. Space: Within 0.5 deg F.
c. Outdoor: Within 1 deg F.

11. Vibration: Within 5 percent of reading.

I. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

1. Current:

a. Milliamperes: Nearest 1/100th of a milliampere.
b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Thermal, Rate:

1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10,000 kW; nearest 100 kW for above 10,000 kW).
2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10,000 kW; nearest 100 kW for above 10,000 kW).

c. Thermal, Usage:

1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatts-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10,000 kWh; nearest 100 kWh for above 10,000 kWh).
2) Cooling: For ton-hours, nearest ton-hours up to 1000 tons-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above

10,000 tons (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatt-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10,000 kWh; nearest 100 kWh for above 10,000 kWh).

3. Flow:

    a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm (Nearest 1/10th of a L/s through 100 L/s; nearest L/s between 100 and 1000 L/s; nearest 10 L/s between 1000 and 10,000 L/s; nearest 100 L/s above 10,000 L/s).
    b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm (Nearest 1/10th of a L/s through 100 L/s; nearest L/s between 100 and 1000 L/s; nearest 10 L/s between 1000 and 10,000 L/s; nearest 100 L/s above 10,000 L/s).

4. Gas:

    a. Carbon Dioxide (ppm): Nearest ppm.
    b. Refrigerant (ppm): Nearest ppm.

5. Moisture (Relative Humidity):

    a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches, nearest 1/10 of an inch between 10 and 100 inches, nearest inch above 100 inches (Nearest 1/100th of a mm through 10 mm, nearest 1/10th of a mm between 10 and 100 mm, nearest mm above 100 mm).
7. Speed:

    a. Rotation (rpm): Nearest 1 rpm.
    b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm (Nearest 1/100th of a M/s through 10 M/s; nearest 1/10th of a M/s above 10 M/s).

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:

    a. Air, Ducts and Equipment: Nearest 1/10th in. w.c. (Nearest Pa up to 1000 Pa, nearest 10 Pa above 1000 Pa).
    b. Space: Nearest 1/100th in. w.c. (Nearest 1/10th Pa).
    c. Steam: Nearest 1/10th psig through 100 psig, nearest psig above 100 psig (Nearest kPa through 1000 kPa, nearest 10 kPa above 1000 kPa).
    d. Water: Nearest 1/10 psig through 100 psig, nearest psig above 100 psig (Nearest kPa through 1000 kPa, nearest 10 kPa above 1000 kPa).

10. Temperature:

    a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    b. Outdoor: Nearest degree.

c. Space: Nearest 1/10th of a degree.
d. Chilled Water: Nearest 1/10th of a degree.
e. Heating Hot Water: Nearest degree.

11. Vibration: Nearest 1/10th in/s (Nearest 1/10th mm/s).
12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.

J. Control Stability: Control variables indicated within the following limits:

1. Flow:

a. Air, Ducts and Equipment, except Terminal Units: Within 2 percent of design flow rate.
b. Air, Terminal Units: Within 5 percent of design flow rate.
c. Water: Within 2 percent of design flow rate.

2. Gas:

a. Carbon Dioxide: Within 50 ppm.

3. Moisture (Relative Humidity):

a. Air: Within 2 percent RH.
b. Outdoor: Within 2 percent RH.

4. Level: Within 2 percent of reading.
5. Pressure:

a. Air, Ducts and Equipment: 0.5 percent of instrument range.
b. Space: Within 0.25 percent of instrument range.
c. Water: Within 0.25 percent of instrument range.

6. Temperature, Dew Point:

a. Air: Within 0.5 deg F.
b. Space: Within 0.5 deg F.

7. Temperature, Dry Bulb:

a. Air: Within 0.5 deg F.
b. Space: Within 0.5 deg F.
c. Chilled Water: Within 0.5 deg F.
d. Heating Hot Water: Within 0.5 deg F.

8. Temperature, Wet Bulb:

a. Air: Within 0.5 deg F.
b. Space: Within 0.5 deg F.

K. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.

    a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.

2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: Type 12.
    b. Outdoors, Unprotected: Type 4X.
    c. Indoors, Heated with Filtered Ventilation: Type 2.
    d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
    e. Indoors, Heated and Air Conditioned: Type 1.
    f. Mechanical Equipment Rooms:

        1) Chiller and Boiler Rooms: Type 4X.
        2) Air-Moving Equipment Rooms: Type 12.

    g. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
    h. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.
    i. Hazardous Locations: Explosion-proof rating for condition.

L. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by instrument and application.

2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: Type 12.
    b. Outdoors, Unprotected: Type 4X.
    c. Indoors, Heated with Filtered Ventilation: Type 2.

d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
e. Indoors, Heated and Air-conditioned: Type 1.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: Type 4X.
2) Air-Moving Equipment Rooms: Type 12.

g. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
h. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.
i. Hazardous Locations: Explosion-proof rating for condition.

M. Electric Power Quality:

1. Power-Line Surges:

a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:

1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

N. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

O. UPS:

1. DDC system products powered by UPS units shall include the following:

a. Desktop workstations.
b. Printers.
c. Servers.
d. Gateways.
e. DDC controllers, except application-specific controllers.

2. DDC system instruments and actuators powered by UPS units shall include the following:

a. Instruments associated with the following systems controlled by DDC system:
b. Dampers and actuators associated with the following systems controlled by DDC system:
c. Valves and actuators associated with the following systems controlled by DDC system:

P. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.5 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than three levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. Level three LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. Level three LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 76,800 bps.

C. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and tenant data and communication networks.

D. System architecture shall be modular and have inherent ability to expand to not less than three times system size indicated with no impact to performance indicated.

E. System architecture shall perform modifications without having to remove and replace existing network equipment.

F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

H. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Basically, create a DDC system LAN that aligns with air-handling system being controlled.

## 2.6 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:

1. Desktop and portable workstation with hardwired connection through LAN port.
2. Portable operator terminal with hardwired connection through LAN port.
3. Portable operator workstation with wireless connection through LAN router.
4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
5. Remote connection through web access.

B. Access to system, regardless of operator means used, shall be transparent to operator.

C. Network Ports: For hardwired connection of desktop or portable workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:

1. Each mechanical equipment room.
2. Each boiler room.
3. Each chiller room or outdoor chiller yard.
4. Each cooling tower location.
5. Each different roof level with roof-mounted air-handling units or rooftop units.
6. Security system command center.
7. Fire-alarm system command center.

D. Desktop Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.

E. Portable Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Connect to DDC system Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
4. Connect to system through a wireless router connected to Level one LAN.
5. Connect to system through a cellular data service.
6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
8. Have dynamic graphic displays that are identical to desktop workstations.

F. POT:

1. Connect DDC controller through a communications port local to controller.
2. Able to communicate with any DDC system controller that is directly connected or with LAN or connected to DDC system.

G. Mobile Device:

1. Connect to system through a wireless router connected to LAN and cellular data service.
2. Able to communicate with any DDC controller connected to DDC system using a dedicated application.

H. Telephone Communications:

1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.

    a. Desktop and Portable Workstations:

        1) Operators shall be able to perform all control functions, report functions, and database generation and modification functions as if directly connected to system LAN.
        2) Have routines to automatically answer calls, and either file or display information sent remotely.
        3) Communications taking place over telephone lines shall be completely transparent to operator.

4) Dial-up program shall maintain a user-definable cross-reference and associated telephone numbers so it is not required to remember or manually dial telephone numbers.

b. DDC Controllers:

1) Not have modems unless specifically indicated for a unique controller.
2) Controllers with modems shall automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
3) Analyze and prioritize alarms to minimize initiation of calls.
4) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.
5) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
6) Call default devices when communications cannot be established with primary devices.

I. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message, and prerecorded phone message to mobile and landline phone numbers.

J. Simultaneous Operator Use: Capable of accommodating up to 20 simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.7 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.

2. CEA-709.1-C.
3. EIA-485A.
4. IP.
5. IEEE 8802-3, Ethernet.

## 2.8 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by LonWorks Testing Laboratories.

C. CEA-709.1-C Protocol:

1. DDC system shall be an open implementation of LonWorks technology using CEA 709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.
2. LNS shall be used for all network management including addressing and binding of network variables.

    a. Final LNS database shall be submitted with Project closeout submittals.
    b. All devices shall be online and commissioned into LNS database.

3. All devices connected to DDC system network(s) shall use CEA-709.1-C protocol and be installed so SCPT output from any node on network can be bound to any other node in the domain.

D. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:

    a. ASHRAE 135.
    b. CEA-709.1-C.
    c. Modbus Application Protocol Specification V1.1b.

2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.

3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by LonWorks Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
6. Gateways shall be used to connect networks and network devices using different protocols.

## 2.9 DESKTOP WORKSTATIONS

A. Description: A tower or all-in-one computer designed for normal use at a single, semi-permanent location.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dell Inc.
2. HP.
3. Lenovo.

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

D. Personal Computer:

1. Minimum Processor Speed:
2. RAM:

    a. Capacity: 8 GB.
    b. Speed and Type: 1333 MHz,

3. Hard Drive:

    a. Media: Solid state.
    b. Number of Hard Drives: One.

4. Optical Read and Write Drive:

    a. Include with at least 2 MB of data buffer.
    b. Type:
    c. Minimum Data Buffer Capacity:

d. Minimum Average Access Time:
e. Nominal Data Transfer Rates:

1) Reading:
2) Writing:

f. Average access time of 150 ms or less.
g. MTBF of at least 100,000 power-on hours.

5. At least four expansion slots of 64 bit.
6. Video Card:

a. Resolution: 1920 by 1200 pixels.
b. RAM: GB

7. Sound Card:

a. At least 128 voice wavetable synthesis.
b. Capable of delivering three-dimensional sound effects.
c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

8. Network Interface Card: Include card with connection, as applicable.

a. 10-100-1000 base TX Ethernet with RJ45 connector port.
b. 100 base FX Ethernet with SC or ST port.

E. Wireless Ethernet, 802.11 a/b/g/n.

1. Optical Modem: Full duplex link for connection to optical fiber cable provided.
2. I/O Ports:

a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
b. One serial port.
c. One parallel port.
d. Two PS/2 ports.
e. One RJ-45.
f. One stereo line-in and headphone/line-out on back panel.
g. One microphone and headphone connector on front panel.
h. One IEEE 1394 on front and back panel with PCI-e card.
i. One ESATA port on back panel.

3. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

F. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.

3. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

G. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

H. Flat Panel Display Monitor:

1. Display:

a. Color display with diagonal viewable area.
b. Digital input signal.
c. Aspect Ratio: 16 to 9.
d. Antiglare display.
e. Tilt adjustable base.
f. Energy Star compliant.
g. Resolution: 1920 by 1080 pixels at 60 Hz with pixel size of 0.277 mm or smaller.
h. Number of Displays: Two.

I. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

J. I/O Cabling: Include applicable cabling to connect I/O devices.

## 2.10 PORTABLE WORKSTATIONS

A. Description: A self-contained computer designed to allow for normal use in different locations and conditions.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Dell Inc.

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Hardware and software shall support local down-loading to DDC controllers.
4. Data transfer rate to DDC controller shall be at network speed.

D. Processor:

1. Minimum Processor Speed:
2. RAM:

a. Capacity: 8 GB.
b. Speed and Type:

3. Hard Drive:

a. Media: Solid state
b. Number of Hard Drives: Two.

4. Video Card: 8 GB of RAM.

E. Input and Output Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 3.0 ports.
4. HDMI port.
5. Ethernet port.
6. IEEE 1394 port.

F. Battery:

1. Capable of supporting operation of portable workstation for a minimum of 8 hours.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Batteries. Two.

G. Keyboard:

1. 85-key backlit keyboard.
2. Full upper- and lowercase ASCII keyset.

H. Integral Pointing Device: Touchpad with two buttons or equivalent pointing device.

I. Network Interface Card: Include card with connection, as application.

1. 10-100-1000 base TX Ethernet with RJ45 connector port.
2. 100 base FX Ethernet with SC or ST port.

J. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
2. Nominal Data Transfer Rates:

a. Reading:
b. Writing:

3. 160-ms access time.

K. Accessories:

1. Nylon carrying case.
2. Docking station.

3. Mobile broadband card.
4. Wireless optical mouse.
5. Light-sensitive web cam and noise-cancelling digital array microphone.
6. Category 6a patch cable. Minimum cable length shall be.
7. HDMI cable. Minimum cable length shall be.

## 2.11 PORTABLE OPERATOR TERMINAL

A. Description: Handheld device with integral keypad or touch screen operator interface.

B. Display: Multiple lines of text display for use in operator interaction with DDC system.

C. Cable: Flexible coiling cable, at least 36 inches (900 mm) long, with a plug-in jack for connection to DDC controllers, network ports or instruments with an integral LAN port. As an alternative to hardwired connection, POT shall be accessible to DDC controllers through a wireless network connection.

D. POT shall be powered through network connection.

E. Connection of POT to DDC system shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.

F. POT shall give operator the ability to do the following:

1. Display and monitor BI point status.
2. Change BO point set point (on or off, open or closed).
3. Display and monitor analog point values.
4. Change analog control set points.
5. Command a setting of AO point.
6. Display and monitor I/O point in alarm.
7. Add a new or delete an existing I/O point.
8. Enable and disable I/O points, initiators, and programs.
9. Display and change time and date.
10. Display and change time schedules.
11. Display and change run-time counters and run-time limits.
12. Display and change time and event initiation.
13. Display and change control application and DDC parameters.
14. Display and change programmable offset values.
15. Access DDC controller initialization routines and diagnostics.

## 2.12 PRINTERS

A. Color Inkjet Printer:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Hewlett-Packard Company.

2. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
3. Print quality of 1200 by dots per inch with black on inkjet paper and 4800 by 1200 dots per inch color printing on premium photo paper.
4. Capable of handling letter- and legal-size paper and overhead transparencies.
5. Duplex printing (printing on both sides of paper).

## 2.13 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple-network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:

    a. Operator access to DDC system shall be under password control.
    b. An alphanumeric password shall be field assignable to each operator.
    c. Operators shall be able to access DDC system by entry of proper password.
    d. Operator password shall be same regardless of which computer or other interface means is used.
    e. Additions or changes made to passwords shall be updated automatically.
    f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
    g. Software shall have at least five access levels.

h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

7. Data Segregation:

a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
b. Include at least 32 segregation groups.
c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.

8. Operators shall be able to perform commands including, but not limited to, the following:

a. Start or stop selected equipment.
b. Adjust set points.
c. Add, modify, and delete time programming.
d. Enable and disable process execution.
e. Lock and unlock alarm reporting for each point.
f. Enable and disable totalization for each point.
g. Enable and disable trending for each point.
h. Override control loop set points.
i. Enter temporary override schedules.
j. Define holiday schedules.
k. Change time and date.
l. Enter and modify analog alarm limits.
m. Enter and modify analog warning limits.
n. View limits.
o. Enable and disable demand limiting.
p. Enable and disable duty cycle.
q. Display logic programming for each control sequence.

9. Reporting:

a. Generated automatically and manually.
b. Sent to displays, printers and disk files.
c. Types of Reporting:

1) General listing of points.
2) List points currently in alarm.

3) List of off-line points.
4) List points currently in override status.
5) List of disabled points.
6) List points currently locked out.
7) List of items defined in a "Follow-Up" file.
8) List weekly schedules.
9) List holiday programming.
10) List of limits and deadbands.

10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.

18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.

    a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
    b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
    c. Keyboard equivalent shall be available for those operators with that preference.

20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:

    a. On-line context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.

        1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.

    c. Available for Every Menu Item:

        1) Index items for each system menu item.

22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.

    a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols similar to those indicated.
    b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:

        1) Define background screens.
        2) Define connecting lines and curves.
        3) Locate, orient and size descriptive text.
        4) Define and display colors for all elements.
        5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

    a. Room layouts with room identification and name.
    b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
    c. Location and identification of each hardware point being controlled or monitored by DDC system.

3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation.

    a. Chilled-water system.
    b. Heating hot-water system.
    c. Fan.
    d. Pump.
    e. Rooftop unit.
    f. Terminal unit.

4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, operator workstations.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:

    a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
    b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
    c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
    d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.

e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
f. Point related change capability shall include the following:

1) System and point enable and disable.
2) Run-time enable and disable.
3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
4) Assignment of alarm and warning limits.

g. Application program change capability shall include the following:

1) Enable and disable of software programs.
2) Programming changes.
3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:

a. Proportional control (P).
b. Proportional plus integral (PI).
c. Proportional plus integral plus derivative (PID).
d. Adaptive and intelligent self-learning control.

1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:

    a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
    b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
    c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
    d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.

5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.

    a. Class 1:

        1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
        2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
        3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.

    b. Class 2:

        1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
        2) Acknowledgement may be through a multiple alarm acknowledgment.

    c. Class 3:

        1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
        2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
        3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.

4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.

d. Class 4:

1) Routine maintenance or other types of warning alarms.
2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Each report shall be definable as to data content, format, interval and date.
3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server for historical reporting.
4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Reports and logs shall be stored on server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.

H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

a. Alarm history.
b. System messages.
c. System events.
d. Trends.

I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

J. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Trends shall be associated into groups, and a trend report shall be set up for each group.
3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
6. When drive storage memory is full, most recent data shall overwrite oldest data.
7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.

K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.

1. Each trend shall include interval, start time, and stop time.
2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server hard drives.
3. Data shall be retrievable for use in spreadsheets and standard database programs.

L. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming software shall be one of the following:

    a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.

        1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
        2) Programming tools shall be viewable in real time to show present values and logical results of each function block.

    b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.
    c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

M. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.

2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

    a. Backup.
    b. Purge.
    c. Restore.

4. Database management software shall support the following:

    a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
    b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
    c. Backup: Include means to create a database backup file and select a storage location.
    d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.

5. Database management software shall include information of current database activity, including the following:

    a. Ready.
    b. Purging record from a database.
    c. Action failed.
    d. Refreshing statistics.
    e. Restoring database.
    f. Shrinking a database.
    g. Backing up a database.
    h. Resetting Internet information services.
    i. Starting network device manager.
    j. Shutting down the network device manager.
    k. Action successful.

6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:

    a. Allow operator to set and review scan intervals and start times.
    b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
    c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
    d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.

e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.

9. Monitoring settings taskbar shall include the following informational icons:

a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

## 2.14 OFFICE APPLICATION SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Microsoft Corporation.

B. Include current version of office application software at time of Substantial Completion.

C. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."

1. Database.
2. E-mail.
3. Presentation.
4. Publisher.
5. Spreadsheet.
6. Word processing.

## 2.15 ASHRAE 135 GATEWAYS

A. Include LonWorks communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. LonWorks -controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.

B. Include gateways to connect LonWorks to legacy systems, existing non- LonWorks devices, and existing non- LonWorks DDC-controlled equipment, only when specifically requested and approved by Owner.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that LonWorks "client" will read, and each parameter that LonWorks network will write to. Describe this interoperability of LonWorks services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non- LonWorks network to LonWorks network and vice versa where applicable.
2. Write to all writeable object properties on non- LonWorks network from LonWorks network and vice versa where applicable.
3. Include single-pass (only one protocol to LonWorks without intermediary protocols) translation from non- LonWorks protocol to LonWorks and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

## 2.16 CEA-709.1-C NETWORK HARDWARE

A. Routers:

1. Network routers, including routers configured as repeaters, shall comply with requirements of CEA-709.1-C and include connection between two or more CEA-709.3 TP/FT-10 channels or between two or more CEA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.
2. IP Routers:

    a. Perform layer three routing of CEA-709.1-C packets over an IP network according to CEA-852-B.
    b. Include appropriate connection to the IP network and connections to CEA-709.3 TP/FT-10 or TP/XF-1250 network.
    c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CEA-852-B Configuration Server (for CEA-852-B configuration), but shall not rely on these services for configuration.
    d. Capable of manual configuration via a console RS-232 port.

B. Gateways:

1. Perform bidirectional protocol translation from one non-CEA-709.1-C protocol to CEA-709.1-C.
2. Incorporate a network connection to a TP/FT-10 network according to CEA-709.3 and a connection for a non-CEA-709.1-C network.

## 2.17 DDC CONTROLLERS

A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.

C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.

F. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within36 inches (900 mm) of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

a. Network Controllers: 70 percent.
b. Programmable Application Controllers: Not less than 80 percent.
c. Application-Specific Controllers: Not less than 90 percent.

2. Memory shall support DDC controller's operating system and database and shall include the following:

a. Monitoring and control.
b. Energy management, operation and optimization applications.
c. Alarm management.
d. Historical trend data of all connected I/O points.
e. Maintenance applications.
f. Operator interfaces.
g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:

a. 20 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:

1) AIs: Three.
2) AOs: Three.
3) BIs: Five.
4) BOs: Five.

2. Programmable Application Controllers:

    a. 20 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: Three.
        2) AOs: Three.
        3) BIs: Five.
        4) BOs: Five.

3. Application-Specific Controllers:

    a. 10 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: Two.
        2) AOs: Two.
        3) BIs: Two.
        4) BOs: One.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. General Requirements for CEA-709.1-C DDC Controllers:

1. Controllers shall be LonMark certified.
2. Distinguishable and accessible switch, button, or pin, when pressed shall broadcast its 48-bit Node ID and Program ID over network.
3. TP/FT-10 transceiver according to CEA-709.3 and connections for TP/FT-10 control network wiring.
4. TP/XF-1250 transceiver according to CEA-709.3 and connections for TP/XF-1250 control network wiring.
5. Communicate using CEA-709.1-C protocol.
6. Controllers configured into subnets, as required, to comply with performance requirements indicated.
7. Network communication through LNS network management and database standard for CEA-709.1-C network devices.
8. Locally powered, not powered through network connection.
9. Functionality required to support applications indicated, including, but not limited to, the following:

    a. Input and outputs indicated and as required to support sequence of operation and application in which it is used. SNVTs shall have meaningful names identifying the value represented by an SNVT. Unless an SNVT of an appropriate engineering type is unavailable, all network variables shall be of an SNVT with engineering units appropriate to value the variable represents.

b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of an SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.

10. Programmable controllers shall conform to LonMark Interoperability Guidelines and have LonMark certification.

K. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection shall be provided for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.

5. AOs:

a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
b. Output signals shall have a range of 4 to 20 mA dc as required to include proper control of output device.
c. Capable of being individually calibrated for zero and span.
d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.

6. BIs:

a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.

d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.

7. BOs:

a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs shall be selectable for either normally open or normally closed operation.
d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
e. Limit use of three-point floating devices to VAV terminal unit control applications, and other applications indicated on Drawings. Control algorithms shall operate actuator to one end of its stroke once every 12 hours for verification of operator tracking.

## 2.18 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system Level one network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.
2. Local Keypad and Display:

    a. Equip controller with local keypad and digital display for interrogating and editing data.
    b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

## 2.19 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.
2. Local Keypad and Display:

a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.20 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

## 2.21 CONTROLLER SOFTWARE

A. General Controller Software Requirements:

1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.

4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:

1. Weekly Schedule:

a. Include separate schedules for each day of week.
b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

a. Include capability for operator to define up to 99 special or holiday schedules.
b. Schedules may be placed on scheduling calendar and will be repeated each year.
c. Operator shall be able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

E. Binary Alarms:

1. Each binary point shall be set to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Each analog object shall have both high and low alarm limits.
2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:

1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:

    a. Reset air-handling unit supply temperature set points.
    b. Reset space temperature set points.
    c. De-energize equipment based on priority.

4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:

    a. Addition and deletion of loads controlled.
    b. Changes in demand intervals.
    c. Changes in demand limit for meter(s).
    d. Maximum shutoff time for equipment.
    e. Minimum shutoff time for equipment.
    f. Select rotational or sequential shedding and restoring.
    g. Shed and restore priority.

7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:

a. Total electric consumption.
b. Peak demand.
c. Date and time of peak demand.
d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:

a. Two-position (on/off, open/close, slow/fast) control.
b. Proportional control.
c. Proportional plus integral (PI) control.
d. Proportional plus integral plus derivative (PID) control.

1) Include PID algorithms with direct or reverse action and anti-windup.
2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
3) Controlled variable, set point, and PID gains shall be operator-selectable.

e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.

2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI and BO points.
2. A high run-time alarm shall be assigned, if required, by operator.

## 2.22 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in a single enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed 36 inches (900 mm) wide and 48 inches (1200 mm) high.
6. Individual wall-mounted double-door enclosures shall not exceed 60 inches (1500 mm) wide and 36 inches (900 mm) high.
7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
8. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 20 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).

12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- (6-mm-) high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.

D. Wall-Mounted, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Hoffman; a brand of Pentair Equipment Protection.

2. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
3. Construct enclosure of steel, not less than:

    a. Enclosure size less than 24 in. (600 mm): 0.053 in. (1.35 mm) or 0.067 in. (1.7 mm) thick.
    b. Enclosure size 24 in. (600 mm) and larger: 0.067 in. (1.7 mm) or 0.093 in. (2.36 mm) thick.

4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be manufacturer's standard.
    b. Interior color shall be manufacturer's standard.

5. Hinged door full size of front face of enclosure and supported using:

    a. Enclosures sizes less than 36 in. (900 mm) tall: Multiple butt hinges.
    b. Enclosures sizes 36 in. (900 mm) tall and larger: Continuous piano hinges.

6. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size less than 24 in. (600 mm): Perforated steel, 0.053 in. (1.35 mm) thick.
    b. Size 24 in. (600 mm) and larger: Solid aluminum, 0.10 in. (3 mm) thick.

7. Internal panel mounting hardware, grounding hardware and sealing washers.
8. Grounding stud on enclosure body.
9. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Hoffman; a brand of Pentair Equipment Protection.

2. Enclosure shall be NRTL listed according to UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide (1500 mm tall by 900 mm wide).
7. Double-door enclosure sizes up to 36 inches tall by 60 inches wide (900 mm tall by 1500 mm wide).
8. Construct enclosure of steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) thick.
    b. Size 24 Inches (600 mm) and Larger: 0.067 inch (1.7 mm) thick.

9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be manufacturer's standard.
    b. Interior color shall be manufacturer's standard.

10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
    b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
    c. Sizes Larger 48 Inches (1200 mm) Tall: Four hinges.

11. Double-door enclosures with overlapping door design to include unobstructed full-width access.

    a. Single-door enclosures 48 inches (1200 mm) and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

12. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches (600 mm): perforated steel, 0.053 inch (1.35 mm) thick.
    b. Size 24 Inches (600 mm) and Larger: Solid aluminum, 0.10 inch (3 mm) thick.

13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Accessories:

1. Electric Heater:

    a. Aluminum housing with brushed finish.
    b. Thermostatic control with adjustable set point from zero to 100 deg F (Minus 18 to 38 deg C).
    c. Capacity: 100, 200, 400, and 800 W as required by application.
    d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake and Exhaust Grilles:

    a. Number and size of fans, filters and grilles as required by application.
    b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
    c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
    d. Thermostatic control with adjustable set point from 32 to 140 deg F (Zero to 60 deg C).
    e. Airflow Capacity at Zero Pressure:

        1) 4-Inch (100-mm) Fan: 100 cfm (47 L/s).
        2) 6-Inch (150-mm) Fan: 240 cfm (113 L/s).
        3) 10-Inch (250-mm) Fan: 560 cfm (264 L/s).

    f. Maximum operating temperature of 158 deg F (70 deg C).
    g. 4-inch (100-mm) fan thermally protected and provided with permanently lubricated ball-bearings.
    h. 6- and 10-inch (150- and 250-mm) fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
    i. Dynamically balanced impellers molded from polycarbonate material.
    j. Fan furnished with power cord and polarized plug for power connection.
    k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
    l. Removable Intake and Exhaust Grilles: stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
    m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of a size to match intake grille.

n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.

3. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:

a. 0.25-inch- (6-mm-) thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit shall be factory or shop installed before shipment to Project.

4. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:

a. 0.125-inch- (3-mm-) thick, polycarbonate window mounted in enclosure door material.
b. Window attached to door with screw fasteners and continuous strip of high-strength double-sided tape around window perimeter.
c. Window kit shall be factory or shop installed before shipment to Project.

5. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:

a. 0.25-inch- (6-mm-) thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit shall be factory or shop installed before shipment to Project.

6. Bar handle with keyed cylinder lock set.

## 2.23 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Siemens Industry, Inc., Building Technologies Division.

2. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
3. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Relays shall have LED indication and a manual reset and push-to-test button.
8. Performance:

a. Mechanical Life: At least 10 million cycles.
b. Electrical Life: At least 100,000 cycles at rated load.

c. Pickup Time: 15 ms or less.
d. Dropout Time: 10 ms or less.
e. Pull-in Voltage: 85 percent of rated voltage.
f. Dropout Voltage: 50 percent of nominal rated voltage.
g. Power Consumption: 2 VA.
h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Siemens Industry, Inc., Building Technologies Division.

2. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
3. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
4. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a dust-tight cover.
7. Include knob and dial scale for setting delay time.
8. Performance:

a. Mechanical Life: At least 10 million cycles.
b. Electrical Life: At least 100,000 cycles at rated load.
c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
d. Repeatability: Within 2 percent.
e. Recycle Time: 45 ms.
f. Minimum Pulse Width Control: 50 ms.
g. Power Consumption: 5 VA or less at 120-V ac.
h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Siemens Industry, Inc., Building Technologies Division.

2. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
3. Relays shall be either DPDT or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with a multibladed plug.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 15 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Square D; by Schneider Electric.

2. Monitors ac current.
3. Independent adjustable controls for pickup and dropout current.
4. Energized when supply voltage is present and current is above pickup setting.
5. De-energizes when monitored current is below dropout current.
6. Dropout current is adjustable from 50 to 95 percent of pickup current.
7. Include a current transformer, if required for application.
8. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Functional Devices Inc.

2. Description:

    a. On-off control and status indication in a single device.
    b. LED status indication of activated relay and current trigger.
    c. Closed-Open-Auto override switch located on the load side of the relay.

3. Performance:

    a. Ambient Temperature: Minus 30 to 140 deg F (Minus 34 to 60 deg C).
    b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.

4. Status Indication:

    a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
    b. Current Sensor Range: As required by application.
    c. Current Set Point: Fixed or adjustable as required by application.
    d. Current Sensor Output:

        1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
        2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
        3) Analog, zero- to 5- or 10-V dc.
        4) Analog, 4 to 20 mA, loop powered.

5. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 enclosure.

## 2.24 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least 100 VA.
3. Transformer shall have both primary and secondary fuses.

B. DC Power Supply:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Acopian Technical Company.

2. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
3. Enclose circuitry in a housing.
4. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
5. Performance:

    a. Output voltage nominally 25-V dc within 5 percent.
    b. Output current up to 100 mA.
    c. Input voltage nominally 120-V ac, 60 Hz.

d. Load regulation within 0.5 percent from zero- to 100-mA load.
e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## 2.25 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS FOR WORKSTATIONS

A. 250 through 1000 VA:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Oneac-Powervar Solutions; Powervar, Inc.

2. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
3. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

   a. Larger-capacity units shall be provided for systems with larger connected loads.
   b. UPS shall provide five minutes of battery power.

4. Performance:

   a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
   b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
   c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
   d. On Battery Output Voltage: Sine wave.
   e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
   f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
   g. Transfer Time: 6 ms.
   h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.

5. UPS shall be automatic during fault or overload conditions.
6. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
7. Include front panel with power switch and visual indication of power, battery, fault and temperature.
8. Unit shall include an audible alarm of faults and front panel silence feature.
9. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
10. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
11. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
12. Include tower models installed in ventilated cabinets to the particular installation location.

B. 1000 through 3000 VA:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Toshiba International Corporation.

2. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
3. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

   a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
   b. UPS shall provide 10 minutes of battery power.

4. Performance:

   a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
   b. Power Factor: Minimum 0.97 at full load.
   c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
   d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
   e. Recharge time shall be a maximum of eight hours to 90 percent capacity.

5. UPS bypass shall be automatic during fault or overload conditions.
6. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
7. Batteries shall be sealed lead-acid type and be maintenance free.
8. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

## 2.26 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least No. 14 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:

1. Wire size shall be a minimum No. 22 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch (50- to 65-mm) lay.

3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 22 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be balanced twisted pair.
2. Comply with the following requirements. Cable shall be plenum rated.
3. Cable shall comply with NFPA 70.
4. Cable shall have a unique color that is different from other cables used on Project.

## 2.27 CONTROL POWER WIRING AND RACEWAYS

A. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

## 2.28 ACCESSORIES

A. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

B. Manual Valves:

1. Ball Type:

a. Manufacturers: Subject to compliance with requirements, provide products by the following:

1) NIBCO INC.

b. Body: Bronze ASTM B 62 or ASTM B 61.
c. Ball: Type 316 stainless steel.
d. Stem: Type 316 stainless steel.
e. Seats: Reinforced PTFE.
f. Packing Ring: Reinforced PTFE.
g. Lever: Stainless steel with a vinyl grip.
h. 600 WOG.
i. Threaded end connections.

2.29 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.

a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size shall be as follows:

a. Operator Workstations: Minimum of 0.5 inch (13 mm) high.
b. Printers: Minimum of 0.5 inch (13 mm) high.
c. DDC Controllers: Minimum of 0.5 inch (13 mm) high.
d. Gateways: Minimum of 0.5 inch (13 mm) high.
e. Repeaters: Minimum of 0.5 inch (13 mm) high.
f. Enclosures: Minimum of 0.5 inch (13 mm) high.
g. Electrical Power Devices: Minimum of 0.25 inch (6 mm) high.
h. UPS units: Minimum of 0.5 inch (13 mm) high.
i. Accessories: Minimum of 0.25 inch (6 mm) high.
j. Instruments: Minimum of 0.25 inch (6 mm) high.
k. Control Damper and Valve Actuators: Minimum of 0.25 inch (6 mm) high.

3. Tag shall consist of white lettering on black background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
5. Tag shall be fastened with drive pins.
6. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

B. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches (38 mm) in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

D. Equipment Warning Labels:

1. Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch (6 mm) beyond white border.

## 2.30 SOURCE QUALITY CONTROL

A. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for products to verify actual locations of connections before installation.

1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:

a. Air-handling units specified in Section 237313 "Pre-Engineered Custom Air Handling Units."
b. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Drives."

## 3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Airflow sensors and switches.

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Pipe-mounted flow meters.
2. Pipe-mounted sensors, switches and transmitters.

## 3.4 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer and supervise installation for compliance with requirements.

1. Programmable application controller.
2. Unit-mounted airflow sensors, switches and transmitters.

3. Relays.

B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. Programmable application controller.
2. Unit-mounted flow and pressure sensors, transmitters and transducers.
3. Relays.

C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.

1. Programmable application controller.
2. Flow and pressure switches.
3. Relays.

## 3.5 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Seal penetrations made in acoustically rated assemblies.

G. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

H. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

I. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

## 3.6 OPERATOR WORKSTATION INSTALLATION

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power each workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's and Architect's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

## 3.7 POT INSTALLATION

A. Install two portable operator terminal(s).

B. Turn over POTs to Owner at Substantial Completion.

C. Install software on each POT and verify that software functions properly.

## 3.8 PRINTER INSTALLATION

A. Provide the following printer(s) at location(s) directed by Owner:

1. Color Inkjet: Quantity, one per desktop workstation.

B. Install printer software on workstations and verify that software functions properly.

## 3.9 GATEWAY INSTALLATION

A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.

B. Test gateway to verify that communication interface functions properly.

## 3.10 ROUTER INSTALLATION

A. Install routers if required for DDC system communication interface requirements indicated.

1. Install router(s) required to suit indicated requirements.

B. Test router to verify that communication interface functions properly.

## 3.11 CONTROLLER INSTALLATION

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply and to UPS units where indicated.

C. Install controller with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches (1800 mm) of finished floor.

F. Installation of Programmable Application Controllers:

1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches (1800 mm) of finished floor.

G. Application-Specific Controllers:

1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

## 3.12 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
2. For NEMA 250, Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align bottom of adjacent enclosures of like size.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

## 3.13 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

## 3.14 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:

1. Operator workstation.
2. Printer.
3. Gateway.
4. Router.
5. DDC controller.
6. Enclosure.
7. Electrical power device.
8. UPS unit.
9. Accessory.

C. Install unique instrument identification on face of each instrument connected to a DDC controller.

D. Install unique identification on face of each control damper and valve actuator connected to a DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
2. Shall be located in highly visible location near power service entry points.

## 3.15 NETWORK INSTALLATION

A. Install balanced twisted pair cable when connecting between the following network devices located in same building:

1. Operator workstations.

2. Operator workstations and network controllers.
3. Network controllers.

B. Install balanced twisted pair cable when connecting between the following:

1. Gateways.
2. Gateways and network controllers or programmable application controllers.
3. Routers.
4. Routers and network controllers or programmable application controllers.
5. Network controllers and programmable application controllers.
6. Programmable application controllers.
7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.

C. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

## 3.16 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

a. Every network device shall have an assigned and documented MAC address unique to its network.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. ARCNET or MS/TP networks: Assign from 00 to 64.

2. Network Numbering:

a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.
c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN shall support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field shall support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".

5. Object Name Property Text for Other Than Device Objects:

a. Object name property field shall support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.

1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

a. Assign object identifier property numbers according to tables indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

## 3.17 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

2. Provide strain relief.
3. Terminate wiring in a junction box.

a. Clamp cable over jacket in junction box.
b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.

4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
5. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
6. Use shielded cable to transmitters.
7. Use shielded cable to temperature sensors.

8. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.

## 3.18 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

## 3.19 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

E. Control Damper Checkout:

1. Verify that control dampers are installed correctly for flow direction.
2. Verify that proper blade alignment, either parallel or opposed, has been provided.
3. Verify that damper frame attachment is properly secured and sealed.
4. Verify that damper actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that damper blade travel is unobstructed.

F. Control Valve Checkout:

1. Verify that control valves are installed correctly for flow direction.
2. Verify that valve body attachment is properly secured and sealed.
3. Verify that valve actuator and linkage attachment is secure.
4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
5. Verify that valve ball, disc or plug travel is unobstructed.
6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

G. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:

    a. Verify sensing element type and proper material.
    b. Verify length and insertion.

3.20 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

J. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

## 3.21 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

## 3.22 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.

4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

## 3.23 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed test checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using LonWorks protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.

18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:

    a. Re-check I/O points that required corrections during initial test.
    b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. After 24 Hours of Second Validation Test:

    a. Re-check I/O points that required corrections during second test.
    b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

   a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:

   a. Reaction to COV and alarm conditions during HLC.
   b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

   a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
   b. All alarms, both binary and analog, are reported and printed; none are lost.
   c. Compliance with response times specified.

6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

## 3.24 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.

3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

E. Prepare and submit closeout submittals when no deficiencies are reported.

F. A part of DDC system final review shall include a demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:

    a. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
    e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    f. Trends, summaries, logs and reports set-up for Project.
    g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.

i. Software's ability to edit control programs off-line.
j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each Network and Programmable Application Controller:

1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
4) Electric Power: Ability to disconnect any controller safely from its power source.
5) Wiring Labels: Match control drawings.
6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

    a) Display of network device status.
    b) Display of LonWorks Object Information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

## 3.25 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

## 3.26 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

## 3.27 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

## 3.28 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

a. Provide not less than 10 days of training total.
b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
c. Total days of training shall be broken into not more than four separate training classes.
d. Each training class shall be not less than three consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 30-minute break between sessions. Morning and afternoon sessions shall be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.

3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

E. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

F. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

G. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

H. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

I. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.

3. Provide a workstation for use by each attendee.

J. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:

    a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.

d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

K. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting and modifying alarms including annunciation and routing.
3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.

L. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

M. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.

4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

# SECTION 232113 - HYDRONIC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following.

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.

### 1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin fittings.

C. RTRP: Reinforced thermosetting resin pipe.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. RTRP and RTRF with adhesive.
2. Pressure-seal fittings.
3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
4. Air control devices.
5. Chemical treatment.
6. Hydronic specialties.

B. Shop Drawings: Detail, at 1/8 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Field quality-control test reports.

D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 150 psig at 200 deg F.
2. Chilled-Water Piping: 150 psig at 200 deg F.
3. Condensate-Drain Piping: 150 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L

B. Wrought-Copper Fittings: ASME B16.22.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.
c. Victaulic Company.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pressure-Seal Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Victaulic Company.

4. Housing: Steel.
5. O-Rings and Pipe Stop: EPDM.
6. Tools: Manufacturer's special tool.
7. Minimum 300-psigworking-pressure rating at 230 deg F.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D.
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Charlotte Pipe and Foundry Company.
   b. KBI (King Bros. Industries).
   c. Viega LLC.

2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Charlotte Pipe and Foundry Company.
   b. KBI (King Bros. Industries).
   c. NIBCO INC.

2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

## 2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.

f. McDonald, A. Y. Mfg. Co.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Matco-Norca, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 150 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elster Perfection.
b. Grinnell Mechanical Products.
c. Matco-Norca, Inc.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.

2. Description:

a. Standard: IAPMO PS 66
b. Electroplated steel nipple. complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

## 2.7 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Griswold Controls.
d. Taco.

4. Body: Bronze, ball or plug type with calibrated orifice or venturi.
5. Ball: Brass or stainless steel.
6. Plug: Resin.
7. Seat: PTFE.
8. End Connections: Threaded or socket.
9. Pressure Gage Connections: Integral seals for portable differential pressure meter.
10. Handle Style: Lever, with memory stop to retain set position.
11. CWP Rating: Minimum 125 psig.
12. Maximum Operating Temperature: 250 deg F

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Griswold Controls.
    d. Taco.
    e. Tour & Andersson; available through Victaulic Company.

4. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
5. Ball: Brass or stainless steel.
6. Stem Seals: EPDM O-rings.
7. Disc: Glass and carbon-filled PTFE.
8. Seat: PTFE.
9. End Connections: Flanged or grooved.
10. Pressure Gage Connections: Integral seals for portable differential pressure meter.
11. Handle Style: Lever, with memory stop to retain set position.
12. CWP Rating: Minimum 125 psig.
13. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    d. Conbraco Industries, Inc.
    e. Spence Engineering Company, Inc.
    f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

4. Body: Bronze or brass.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: Brass.
7. Stem Seals: EPDM O-rings.
8. Diaphragm: EPT.
9. Low inlet-pressure check valve.
10. Inlet Strainer: Stainless steel, removable without system shutdown.
11. Valve Seat and Stem: Noncorrosive.

12. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    d. Conbraco Industries, Inc.
    e. Spence Engineering Company, Inc.
    f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

4. Body: Bronze or brass.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: Brass.
7. Stem Seals: EPDM O-rings.
8. Diaphragm: EPT.
9. Wetted, Internal Work Parts: Brass and rubber.
10. Inlet Strainer: Stainless steel, removable without system shutdown.
11. Valve Seat and Stem: Noncorrosive.
12. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Flow Design Inc.
    b. Griswold Controls.

4. Body: Brass or ferrous metal.
5. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
6. Combination Assemblies: Include bonze or brass-alloy ball valve.
7. Identification Tag: Marked with zone identification, valve number, and flow rate.
8. Size: Same as pipe in which installed.
9. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

10. Minimum CWP Rating: 175 psig.
11. Maximum Operating Temperature: 200 deg F.

2.8 AIR CONTROL DEVICES

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:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

D. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

A. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

B. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg F.

## 2.9 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

D. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inchmisalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

# PART 3 - EXECUTION

## 3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condensate-Drain Piping: Type L, Seamless copper tube, ASTM B88, Type L Hard drawn, wrought-copper fittings, and ASTM B828 Lead-Free soldered joints with ASTM B32 Grade HB, Grade HN or approve equal.

## 3.2 VALVE APPLICATIONS

A. Install shut off-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

## 3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

## 3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feetor longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feetor longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 4 and Smaller: Continuously supported by metallic CTS support channels or metallic V-channels that are:

    a. Are supported every 6 feet for NPS 1 and smaller.
    b. Are supported every 8 feet for NPS 1-1/4 to NPS 4.

c. Have a maximum cantilever, measured from the support to the end of the CTS support channel, of 1.5 feet.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

## 3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

## 3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

H. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

## 3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

## 3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely -automatic type, or bleed air completely -manual type.
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

# SECTION 232116 - HYDRONIC PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## PART 2 - PRODUCTS

### 2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong Pumps, Inc.
b. Bell & Gossett; a Xylem brand.
c. TACO Comfort Solutions, Inc.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

B. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett; a Xylem brand.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

C. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flow Design, Inc.
b. Griswold Controls.
c. Nexus Valve, Inc.
d. NIBCO INC.

2. Body: Brass or ferrous metal.
3. Flow Control Assembly, provide either of the following:

a. Piston and Spring Assembly: Corrosion resistant, tamper proof, self-cleaning, and removable.

b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig (14- to 550-kPa) differential pressure.

4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow within plus or minus 10 percent regardless of system pressure fluctuations.
8. Minimum CWP Rating: 175 psig (1207 kPa).
9. Maximum Operating Temperature: 200 deg F (93 deg C).

## 2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett; a Xylem brand.
d. TACO Comfort Solutions, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/8 (DN 6).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 225 deg F (107 deg C).

## 2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

## 2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.

3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

## PART 3 - EXECUTION

### 3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

### 3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

END OF SECTION 232116

# SECTION 232123 - HYDRONIC PUMPS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.

### 1.3 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For each pump.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

    a. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: **One** mechanical seal for each pump.

# PART 2 - PRODUCTS

## 2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett, a Xylem brand.
2. Armstrong Fluid Technology.
3. GRUNDFOS CBS Inc.
4. Taco Comfort Solutions.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

D. PL Pump:

1. The pumps shall be of the horizontal, permanently lubricated type, specifically designed and guaranteed for quiet operation.
2. The pumps shall have a steel shaft supported by permanently lubricated, sealed precision ball bearings. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on silicon carbide. The motor shall be non-overloading at any point on the pump performance curve.
3. The motor shall be of the drip-proof, sealed precision ball bearing, quiet-operating construction. The permanent split capacitor motor shall be equipped with thermal overload protection.
4. Pumps to be suitable for 225°F operating temperature at 150 psig working pressure.

E. NRF Pump:

1. The pumps shall be of the horizontal system lubricated type specifically designed and guaranteed for quiet operation.
2. The pumps shall have a ceramic shaft supported by carbon bearings. Bearings are to be lubricated by the circulating fluid.
3. Pump body shall be lead-free bronze for NBF circulators or stainless steel for SSF circulators.
4. Motor stator to be isolated from circulating fluid through use of stainless steel can. Rotor to be sheathed in stainless steel.
5. Motors shall be non-overloading at any point on the pump curve. NBF-36 & NBF-45 to have built-in thermal protection. All other motors to have built-in impedance protection.
6. NBF-25 has an optional check valve.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PUMP INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

## 3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

## 3.4 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

F. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

## 3.5 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

## 3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Hydronic pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

# SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes pipe and fittings for LP steam and condensate piping:

1. Steel pipe and fittings.

B. Related Requirements:

1. Section 232216 "Steam and Condensate Heating Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Steel pipe and fitting.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fiberglass Pipe and Fitting Installers: Installers of fiberglass pipe and fittings shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. LP Steam Piping: 15 psig.
2. Condensate Piping: 5 psig at 250 deg F.
3. Makeup-Water Piping: 80 psig at 150 deg F.
4. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
5. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

## 2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

## PART 3 - EXECUTION

### 3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

### 3.2 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Vacuum-Breaker Piping: Outlet, same as service where installed.

C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

## 3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet .
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

## 3.4 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Section 232216 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

## 3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping and steel steam condensate piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within 12 inches of each fitting.

G. Support vertical runs of steel steam supply piping and steel steam condensate piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

## 3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

## 3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

## 3.8 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Prepare test and inspection reports.

END OF SECTION 232213

# SECTION 232216 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes the following piping specialties for steam and condensate piping:

1. Strainers.
2. Stop-check valves.
3. Steam traps.
4. Flexible connectors.
5. Steam meters
6. Condensate meters.

B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Strainer.
2. Flash tank.
3. Valve.
4. Steam trap.
5. Connector.
6. Meter.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. LP Steam Piping: 15 psig.
2. Condensate Piping: 5 psig at 250 deg F .
3. Makeup-Water Piping: 80 psig at 150 deg F.
4. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
5. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

### 2.2 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer or perforated stainless-steel basket.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

B. Basket Strainers:

1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig working steam pressure.

### 2.3 STOP-CHECK VALVES

A. Stop-Check Valves:

1. Body and Bonnet: Malleable iron.
2. End Connections: Flanged.
3. Disc: Cylindrical with removable liner and machined seat.

4. Operator: Outside screw and yoke with cast-iron handwheel.
5. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
6. Pressure Class: 250.

## 2.4 STEAM TRAPS

A. Thermostatic Steam Traps:

1. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
2. Trap Type: Balanced pressure.
3. Bellows: Stainless steel or monel.
4. Head and Seat: Replaceable, hardened stainless steel.
5. Pressure Class: 125.

B. Thermodynamic Steam Traps:

1. Body: Stainless steel with screw-in cap.
2. End Connections: Threaded.
3. Disc and Seat: Stainless steel.
4. Maximum Operating Pressure: 600 psig.

C. Float and Thermostatic Steam Traps:

1. Body and Bolted Cap: ASTM A126 cast iron.
2. End Connections: Threaded.
3. Float Mechanism: Replaceable, stainless steel.
4. Head and Seat: Hardened stainless steel.
5. Trap Type: Balanced pressure.
6. Thermostatic Bellows: Stainless steel or monel.
7. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
8. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
9. Maximum Operating Pressure: 125 psig.

D. Inverted Bucket Steam Traps:

1. Body and Cap: Cast iron.
2. End Connections: Threaded.
3. Head and Seat: Stainless steel.
4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
5. Bucket: Brass or stainless steel.
6. Strainer: Integral stainless-steel inlet strainer within the trap body.
7. Air Vent: Stainless-steel thermostatic vent.
8. Pressure Rating: 250 psig.

E. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.

2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig .
5. Maximum Operating Temperature: 250 deg F.

## PART 3 - EXECUTION

### 3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

### 3.2 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full-port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment and elsewhere as indicated.

D. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full-port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

### 3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

C. Install safety valve downstream from pressure-reducing valve station.

## 3.4 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.

B. Provide data acquisition wiring. See Section 230923 "Direct Digital Control (DDC) System for HVAC"

## 3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION 232216

# SECTION 233113 - METAL DUCTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Sealant and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Mockups:

1. Before installing duct systems, build mockups representing static-pressure classes in excess of 3-inch wg. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

a. Five transverse joints.
b. One access door.
c. Two typical branch connections, each with at least one elbow.
d. Two typical flexible duct or flexible-connector connections for each duct and apparatus.
e. One 90-degree turn with turning vanes.
f. One fire damper
g. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ductmate Industries, Inc.
    b. Elgen Manufacturing.
    c. Linx Industries -formerly Lindab.
    d. McGill AirFlow LLC.
    e. MKT Metal Manufacturing.
    f. SEMCO LLC.
    g. Sheet Metal Connectors, Inc.
    h. Spiral Manufacturing Co., Inc.
    i. Stamped Fittings Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: Black.
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.

3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel both PVC coated and bare, stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D -EPA Method 24.
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel both PVC coated and bare, stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

# PART 3 - EXECUTION

## 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class A.
5. Unconditioned Space, Return-Air Ducts: Seal Class A.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
8. Conditioned Space, Return-Air Ducts: Seal Class A.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
    c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
    d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.8 DUCT CLEANING

A. Clean new and existing duct system before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size or larger particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets -registers, grilles, and diffusers.
2. Supply, return, and exhaust 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, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. 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 fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. 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.
6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

## 3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

## 3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Variable-Volume Air-Handling Units Insert equipment:

a. Pressure Class: Positive 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round: 3.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting ASHRAE 62.1, Class 1 and 2 Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Outdoor-Air -Not Filtered, Heated, or Cooled Ducts:

1. Ducts Connected to Air Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1 Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2 Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1 Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2 Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3 Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1 Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2 Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3 Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1 Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2 Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3 Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4 Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

# SECTION 233300 - AIR DUCT ACCESSORIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Flange connectors.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

B. Related Requirements:

### 1.3 ACTION SUBMITTALS

A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports. Silencer manufacturer to provide a copy of their laboratory NVLAP accreditation certificate for the ASTM E-477-06a test standard with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with 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.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

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 minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Lloyd Industries, Inc.
3. Nailor Industries Inc.
4. Ruskin Company.
5. Vent Products Co., Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 6-inch wg.

E. Frame: Hat-shaped, 0.03-inch-thick stainless steel, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Felt.

I. Blade Axles:

1. Material: Stainless steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
    a. Sleeve Thickness: 20 gage minimum.
    b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.

9. 90-degree stops.

## 2.4 MANUAL VOLUME DAMPERS

A. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. McGill AirFlow LLC.
    b. Nailor Industries Inc.
    c. Ruskin Company.
    d. Vent Products Co., Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

6. Blade Axles: Stainless steel.
7. Bearings:

    a. Stainless-steel sleeve.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.
9. Provide locking quadrants.

B. Accessories:

1. Auxiliary switches for fan control or position indication.
2. Test and reset switches, damper mounted.

## 2.5 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Hardcast, Inc.

4. Nexus PDQ.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

## 2.6 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aero-Dyne Sound Control Co.
2. Ductmate Industries, Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO LLC.
6. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Double wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.7 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Elgen Manufacturing.
3. Flexmaster U.S.A., Inc.
4. Greenheck Fan Corporation.

5. McGill AirFlow LLC.
6. Nailor Industries Inc.
7. Pottorff.
8. Ward Industries; a brand of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

## 2.8 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. JP Lamborn Co.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.10 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: 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 positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Adhesive.

## 2.11 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

## 3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain

applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install silencer according to manufacturer’s written installation instructions.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Control devices requiring inspection.
10. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with adhesive.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.
4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

# SECTION 237313 - PRE-ENGINEERED CUSTOM AIR-HANDLING UNITS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 DESCRIPTION OF WORK

A. Custom-built air handling units shall be supplied to meet the performance requirements shown on the contract drawings, schedules and specifications. To comply with jobsite constraints the units shall be shipped completely “knocked-down” with all parts shrink wrapped and palletized or crated for shipment. All unit parts and components shall be designed and constructed to allow them to pass through the jobsite opening(s) restrictions. Manufacturer’s authorized Sales Representative shall perform a field survey with the installing Contractor to confirm all jobsite constraints and opening restrictions.

B. The contractor shall be responsible for inspecting shipments upon arrival at the jobsite or riggers yard. Any freight damage shall be documented on the packing slip and submitted to the truck drivers before departure from the delivery site. Rigging, installation, sealing of modules and field start-up work shall be executed by the mechanical contractor as outlined in the project specifications.

### 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 150 percent of design internal operating pressure, without panel joints exceeding a deflection of L/240 where “L” is the span length of the panel.

B. Air Leakage Performance: Air leakage shall not exceed 0.5% of the total design air flow at 150 percent of the design internal operating pressure or 50 CFM, whichever is greater.

### 1.4 SUMMARY

A. Product Data: For each air-handling unit.

1. Unit layout drawings, noting overall unit dimensions, opening/damper sizes and locations, access door sizes and locations, drain pan/floor drain pan connection locations and weights.
2. Unit construction details, including metal gauges and material and insulation.
3. Components, where applicable:

    a. Fans, including fan curves, sound data, construction and accessories.
    b. Motor performance data and curves.

c. Certified coil performance data.
d. Dampers, including actuators for smoke dampers.
e. Filter performance data.
f. Vibration isolation data.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

## 1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Source quality-control reports.

C. Startup service reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

## 1.8 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## 2.2 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements but are not limited to, the following.

1. Ingenia Technologies Inc
2. Miller Picking

3. Air Enterprise

B. Alternate manufacturers must comply with performance data and specifications without impacting the equipment performance or design features including duct connection location, unit weights, acoustic performance, or specified total fan HP for each fan array.

## 2.3 GENERAL DESCRIPTION

A. The units must not be operated, for temporary or permanent purposes, until start-up has been completed by an authorized Ingenia Technologies serviceman and witnessed by installing Contractor.

B. All deviations from the specification must be clearly indicated on the submittal drawings. The contractor shall be held responsible for all additional expenses associated with the substitution of the specified product.

## 2.4 CABINET DESIGN

A. The cabinet shall be designed to withstand a maximum pressure of 150 percent of design internal operating pressure.

## 2.5 UNIT BASE

A. Unit base frame shall be constructed of aluminum HSS tubing. The unit base frame shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning.

B. Unit base perimeter frame members and intermediate base frame support members, for supporting panelized floors, shall be the same height. Framing members shall be joined with 3/8” tapered head machine bolts. All assembly hardware shall be stainless steel.

C. The unit base frame height shall be selected to meet the structural design load. The maximum base deflection shall not exceed 1/600, given a maximum unsupported span of 8 feet (96”).

D. The minimum unit base frame height shall be tall enough to ensure sufficient height for field installed condensate P-traps.

E. Each unit base piece shall be equipped with a minimum of four (4) removable lifting lugs. The maximum space between the lifting lugs shall be 6 feet.

F. To ensure sustained product life, all structural base components shall be made of aluminum, and baked powder coated. Galvanized or carbon steel components are NOT acceptable.

## 2.6 FLOOR SURFACE, FLOOR INSULATION, AND UNDERLINER

A. The internal walkable floor surfaces shall be diamond plate, 0.125" thick, aluminum. All mating surfaces must be smooth aluminum.

B. Floor surfaces shall consist of multiple individual foam injected panels. To minimize heat gains/losses through the flooring system, the floor panels shall include a complete no-through-metal break, to provide complete thermal isolation from unit base. Epoxy bridge, gaskets or tapes are NOT acceptable forms of no-through-metal break.

C. The panel-to-panel joining method shall be continuously welded and guaranteed to be watertight for the life of the unit. All fasteners must be concealed to ensure air and water tightness and provide smooth surfaces.

D. Individual panelized floors shall be insulated with injected hydrophobic polyurethane foam to ensure a complete insulation fill, prevent oil-canning, and provide the highest possible thermal resistance. Floor panel thickness shall be 4.0 inches. The resulting thermal resistance shall be R-26. Use of fiberglass insulation, spray-on insulation, foam board, or mineral wool for floors is NOT acceptable. Non-panelized floor systems are NOT acceptable.

E. The interior of the unit shall be suitable for washdown construction. A 2” high, 45 deg. sloped water retention collar shall be installed around the interior perimeter of the unit floors to ensure that unit is internally watertight. Sloped collars shall be continuously welded to floors. All floors shall be drainable and have machined aluminum catch basins with removable stainless-steel grates. Stainless steel drainpipes shall be installed from each catch basin to the exterior of the unit.

F. The underside floor liners shall be aluminum.

G. All floor openings shall be equipped with a 2" water retention collar to prevent water migration into the floor opening. Air inlet and discharge openings shall be protected with aluminum flat bar grating.

## 2.7 UNIT CASING

A. All panels shall be double wall construction, load-bearing and capable of forming the enclosure. All panel joints shall be sealed to provide a permanent air-tight seal. Panel widths shall be regulated to eliminate panel pulsation and restrict the maximum deflection to 1/240 at the specified design conditions.

B. Individual panels shall be insulated with injected hydrophobic polyurethane foam, a material that does not absorb nor transmit water, thereby eliminating the risk of bacterial proliferation, mildew and mold. Fiberglass insulation, spray-on insulation, foam board, or mineral wool is NOT acceptable. Each panel shall have a complete no-through-metal break consisting of High-Density Polyethylene (HDPE) separators, designed to interconnect the outer and inner panel skins and eliminate metal to metal contact. No-through-metal construction designed with an epoxy bridge, gasket, or tapes are NOT acceptable forms of no-through-metal break.

C. All panels shall be a minimum of 3.0 inches thick and be insulated with polyurethane foam having an R-value equal to 19.5.

D. Adjacent panels shall be assembled to each other with aluminum compression plates, compressed rubber butyl membranes, 1/4” bolts and hex-shaped rivet nuts. The rivet nuts shall be installed in panel outer skins. Adjacent panels shall be joined together by placing rubber butyl membrane over the exterior seam where adjacent panels join and bolting on full height

compression plates over the membrane with 1/4” bolts, screwed into the hex-shaped rivet nuts. The compression plates shall be mounted on the exterior of the units, exposing the assembly bolts to the exterior of the unit. Each panel shall be removable, allowing access to all internal parts and components. The 1/4” bolts shall be stainless-steel. Self-tapping screws or rivets are NOT acceptable.

E. To provide a cleanable internal finish and ensure a long product life, all internal panel joints shall be sealed with a non-silicon based caulking compound.

F. To prevent internal cabinet corrosion, all air-side panel joints shall include a solid vapor barrier thereby preventing moisture migration into the wall space. The internal seal shall be resistant to pressure wash down cycles.

G. The panels exterior and interior skins shall be 14-gauge aluminum.

1. The cooling coil and humidifier sections must have 304SS internal skins.

H. The construction of panel walls shall conform to the standards ASTM E84-10 and CAN / ULC S102-07 with regards to smoke developed and flame propagation.

I. Units shall not include removal plug panels, as they are a source for leakage, but incorporate a design which allows each panel to be removable, allowing access to all internal parts and components, for future maintainability and service.

## 2.8 INTERIOR AND EXTERIOR POWDER COATING FINISH

A. To ensure sustained product life, unit perimeter base frame, exterior and interior panel skins shall be electrostatically baked powder coated, as described below.

1. The powder coating process shall include a 5-stage de-greasing, washing and drying system, which includes pre-washing, rinsing, re-washing, rinsing cycle l, rinsing cycle l and oven drying @ 400 °F.
2. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded workpiece create an electrostatic field that pulls the paint particles to the workpiece. The coating deposited on the workpiece retains its charge, which holds the powder to the workpiece. The coated workpiece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOC’s), hazardous air pollutants (HAP’s) and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 10,000 hours to the Standard ASTM-B117 salt spray test.
3. The interior skin of casing panels (including the cooling coil and humidifier sections) shall be an anti-microbial powder coating.
4. Coating must be applied after panel formation in AHU manufacturer’s facility. Forming of pre-coated material is NOT acceptable.

## 2.9 ACCESS DOORS

A. Each unit section shall have a 24 inch wide access door clearly shown differently on drawings. The fan section access door shall be sized to allow removal of fan wheel and motor.

B. Each door panel and door frame shall have a complete no-through-metal break consisting of High-Density Polyethylene (HDPE) separators, installed continuous around both the door panel and door frame perimeter, designed to interconnect the front and rear extruded aluminum door panel and door frame angles and eliminate metal to metal contact. Assembled door panels are injected with same foam insulation as unit casing panels. Door frames shall be bolted to casing panels. Epoxy bridge, gasket, or tapes are NOT acceptable forms of no-through-metal break.

C. Doors shall be the same thickness as unit casing and be insulated with polyurethane foam having an R-value equal to the unit casing. The door panels shall be double wall construction.

D. The front door panel frame shall be constructed of 3/16” extruded aluminum and shall be bolted to the door panels. The front door panel frame shall incorporate (4) 90 degree extruded aluminum pressure seal corner pieces.

E. Each access door shall include either (2) two or (3) three precision machined aluminum hinges and latches which shall be operable from both the inside and outside of the unit. Hinges shall be precision milled, with hinge pins fitting into bronze bushings. Hinges shall be bolted to door panels with 1/4” stainless steel bolts. Piano style hinges are NOT acceptable.

F. The air seal between the door and its frame shall be accomplished with a dual formed-in-place foam gasket. Before applying gaskets, all gasketed surfaces are to be prepped with an ethanol-based primer. The application process of the liquid polyurethane gaskets shall be robotically performed by high pressure injection, providing seamless gaskets. The dual gasket system is designed to provide two points of contact providing a high level of thermal resistance. Self-adhesive gaskets are NOT acceptable.

G. Each access door shall be equipped with at least two door handles that shall be easy to operate from both sides of the door and be made of fiberglass reinforced with nylon.

H. Each door shall include a square double pane thermal-tempered glass window and properly sealed to operate safely against suction or positive pressure conditions. Windows shall be constructed like door panels and shall incorporate no-through-metal break.

I. All access doors shall have built-in static pressure ports for ease of reading static pressure across internal components therefore limiting unnecessary or unauthorized access inside the unit. Test ports shall be equal to DynAir PTP-1. Test ports shall be installed on access door panels through a custom-made HDPE block for complete no-through-metal design.

J. All access doors shall be assembled with bolts and screws. Access doors constructed with tek-screws or caulk are NOT acceptable.

## 2.10 FAN ARRAY SYSTEM

A. The Fan Array system shall consist of multiple, direct driven, wall mounted, arrangement 4 plenum fans constructed per AMCA requirements for specified duty. Fans shall be selected to deliver scheduled airflow at scheduled total static pressure and scheduled fan/motor speed.

B. All fans shall be certified to bear the AMCA® rating seal for air and sound, according to Standards AMCA® 210-99.

C. Impellers shall be made of aluminum with backward curved, profiled blades and efficiency optimized circumferential diffusor. The impellers shall be statically and dynamically balanced with hubs according to quality level G6.3 (BV-3).

D. The inlet cones hall be made of galvanized steel.

E. Each fan/motor shall be provided with individual adjustable counterweighted heavy-duty back-draft damper.

F. Acceptable manufacturer:

1. Rosenberg model GKHM or equivalent.

## 2.11 FAN MOTORS

A. Provide each fan with an electrically commutated (EC) motor. EC motor shall be permanent excited synchronous motor in external rotor design.

B. Provide IE5 (Ultra Premium Efficiency) motors with maintenance free ball bearings, closed on both sides with long-term lubrication.

C. Motors shall be made of die cased aluminum and motor magnets shall be made without rare earth elements.

D. Motor shall be designed for continuous duty operation, with class F insulation.

E. Motors shall be 100% speed controllable with integrated motor protection and soft start capability.

F. Acceptable motor manufactures:

1. Rosenberg or equivalent.

## 2.12 AIRFLOW MEASURING, MONITORING, AND CONTROL SYSTEM

A. A controller shall be provided as an integral part of the fan system electrical panel. Through a touch screen user interface, the controller can provide multiple functions. The fan array controller shall include an interface that is compatible with the building automation system and allow remote monitoring and/or control of the individual fans in the array. Each fan array control panel shall include motor status indicators, operating mode, individual fan air flow, total air flow and alarms. Component’s status shall be displayed at the unit control interface screen

and at the remote building automation system. A communication interface with the BAS system shall be provided by the AHU manufacturer and shall require a single interface point at the multiple fan array system control panel by the project controls contractor. The controller interface shall be BACnet/IP (standard).

B. The air handling unit manufacturer shall provide a piezometer ring system mounted in the throat of each fan to enable the measurement of the pressure drop across the inlet cone.

C. The pressure drop is measured from the tap located on the face of the funnel to the piezometer ring in the throat. The inlet tap is connected to the high pressure side of the transducer and the piezometer ring is connected to the low pressure side.

D. The measurement system shall not impact the airflow characteristics in any way, resulting in a zero system effect.

E. The accuracy of the system shall be +/- 5%.

## 2.13 HEATING COIL SECTION

A. The heating coil rack assembly must be designed to allow for the individual removal of multi-stacked coils. Rack assembly shall be constructed of aluminum structural tubing. Each stacked heating coil shall have its own individual accessible panel that will enable the ability to remove an individual stacked coil, without removing the adjacent coil or coil piping of the adjacent stacked coils. Entire rack assembly and blank-off plates shall be assembled with bolts, to allow for easy removal. Bolts shall be stainless steel. Blank-off plates shall be aluminum material.

B. All coil piping connections must be extended to the exterior of the cabinet through flexible vinyl sealing gromets.

C. Hot water heating coils shall be constructed of 0.035” tube wall, 5/8” OD seamless copper tubes with 0.010” corrugated aluminum plate fins. The casing shall be minimum 16-gauge galvanized steel with bolted side panels and top and bottom panels, with stacking flanges. Intermediate supports shall be provided as needed for a rigid design. Headers shall be copper with MPT red brass connections. Each coil shall be hydrostatically tested up to 300 psig and shall be designed for continuous operation at 200 psig and 220 deg. F. Coils shall be both AHRI and ETL certified.

D. Acceptable heating coil manufacturers:

1. Ingenia, Aerofin or Direct Coil.

## 2.14 COOLING COIL SECTION

A. The cooling coil rack assembly must be designed to allow for the individual removal of multi-stacked coils. Rack assembly shall be constructed 304SS structural tubing. Each stacked cooling coil shall have its own individual accessible panel that will enable the ability to remove an individual stacked coil, without removing the adjacent coil or coil piping of the adjacent stacked coils. Entire rack assembly and blank-off plates shall be assembled with bolts, to allow for easy

removal. Bolts shall be stainless steel. Blank-off plates shall be the same material as coil casings.

B. Each stacked cooling coil shall have individual (secondary) rack with fully welded stainless steel sloped drain pans, with stainless steel downspouts. Secondary “gutter” drain pans shall NOT be acceptable. The secondary rack assembly and drain pans shall be fabricated entirely of 304 stainless steel and include stainless steel downspouts at drain pan’s low point.

C. Main lower drain pans for both cooling coil and humidifier sections shall be fabricated of 304SS, fully welded. Drain pans to be recessed into floor panels and insulated with injected polyurethane foam to ensure a complete and uniformly protective cavity eliminating the risk of condensation under the unit. To ensure positive water flow the surfaces shall be triple-sloped and have a depth of 2”. Each drain connection requires an independent external P-trap, provided and installed by others.

D. Drain connections shall be schedule 40-pipe 304 stainless steel with MPT connections. The diameter shall be minimum 1-1/2" diameter. The drain connection shall be accessible from the exterior of the unit casing.

E. All coil piping connections that extend to the exterior of the cabinet shall do so through flexible vinyl sealing gromets. Cooling coils shall have rubber gromets on both sides of panel.

F. Chilled water cooling coils shall be constructed of 0.035” tube wall, 5/8” OD seamless copper tubes with 0.010” corrugated aluminum plate fins. The casing shall be minimum of 16-gauge 304 stainless steel with bolted side panels and top and bottom panels, with stacking flanges. Intermediate supports shall be provided as needed for a rigid design. Headers shall be copper with MPT red brass connections. Each coil shall be hydrostatically tested up to 300 psig, and shall be designed for continuous operation at 200 psig and 220 deg. F. Coils shall be both AHRI and ETL certified.

G. Acceptable cooling coil manufacturers or equal:

1. Ingenia, Aerofin or Direct Coil.

## 2.15 FILTER SECTIONS

A. Filters shall be front loading whenever an accessible section is available upstream of the filter section. The front-loading filter frames shall be made of aluminum structural extrusions for maximin rigidity. The blank-off plates shall be aluminum and shall be bolted to hex-shaped rivet nuts embedded in the structural extrusions. Butyl sealing membranes shall be added behind the blank-off plates to ensure air tightness. Filters are held in place with “keyhole fast-access clips” secured with 1/4” stainless steel bolts. (4) four clips per filter, no matter what the filter size. Wire style holding clips and galvanized filter frames are NOT acceptable.

B. Filter frame gaskets shall be accomplished with a formed-in-place foam gasket. Before applying gaskets, all gasketed surfaces are to be prepped with an ethanol-based primer. The application process of the liquid polyurethane gaskets shall be robotically performed by high pressure injection, providing seamless gaskets. Self-adhesive gaskets are NOT acceptable.

C. Provide for each filter bank, pressure differential gauge(s) manufactured by Dwyer® under the brand name Magnahelic Model 2004D series. Common filter banks holding both a prefilter and a cartridge filter, shall include a spacer frame and (2) gauges per bank for independent pressure drop measurement across each pre-filter and cartridge filter.

D. Provide (1) set of 2" thick MERV 8 prefilters equal to AAF high capacity PerfectPleat HC M8. Filters shall be self-supporting with virgin fiber media. Perimeter frames shall be constructed of the highest strength wet-strength 28 pt. beverage carrier board, securely bonded to media pack. Initial pressure drop shall not exceed 0.23" w.g. at 500 FPM. Performance shall be based on ASHRAE Standard 52.2.

E. Provide (1) set of 12" deep MERV 14 bag filters equal to AAF DriPak 2000 extended surface, high-capacity pocket filter. Filter media shall be Synthetic, non-shedding, moisture-resistant media. Initial pressure drop shall not exceed 0.40" w.g. at 500 FPM. Performance shall be based on ASHRAE Standard 52.2.

## 2.16 ULTRA-SORB® MODEL MP STEAM DISPERSION PANEL HUMIDIFIERS

A. DriSteem Corporation, Ultra-sorb steam dispersion panels

B. Certifications

1. ISO 9001:2015 for Design and Manufacture of Systems for HVAC Applications
2. HCAI Seismic Certification preapproval

C. Product shall be warranted to be free from defects in materials and fabrication for a period of two years after installation or 27 months from ship date, whichever comes first.

D. The Ultra-sorb steam dispersion panel shall directly inject pressurized boiler steam into AHU for humidification.

E. Steam dispersion panels shall be factory-assembled and include the following components:

1. Steam supply and condensate collection header.
2. Galvanized metal frame panel sized as specified in the humidifier schedule.
3. Steam dispersion tubes spanning the distance between the steam header and top of framed panel.

F. Each dispersion tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall, to meet specified absorption distances. The two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow.

G. Each tubelet shall extend through the wall of and into the center of the dispersion tube and contain a steam orifice sized for its required steam capacity.

H. Steam supply and condensate drain piping connections to panel shall both be provided within 6" of the humidifier panel bottom corner, on common side of AHU or duct designated on drawing, to minimize exterior piping runs.

I. Provide any blank-off plates required to prevent airflow bypassing humidifier face area.

J. Each packaged humidifier panel assembly of steam header and tubes shall be contained within a galvanized metal casing to expedite duct mounting, or to facilitate the stacking of and/or the end-to-end mounting of multiple humidifier panels in ducts or air handler casings. When so designated, the humidifier panel shall be shipped unassembled.

K. All tubes and header shall be 316 stainless steel unless otherwise noted in Humidifier Options below, and welded joints shall be Heli-arc welded.

L. Tubes shall be fitted to the steam header utilizing compression-fit sealing grommets to facilitate easy removal. The top of dispersion tubes shall be attached to humidifier frame, and allow for removal with common tools.

M. Inlet strainer and entire control valve shall be stainless steel.

N. Pressurized steam components for use with boiler steam:

1. Valve options:

a. Modulating electronic humidification steam control valve: Valve shall be a normally closed with an electronic actuator. Valve trim shall be stainless steel, and sized to meet humidification requirements. Actuator shall respond to a variable electronic signal of 2 to 10 VDC or 4 to 20 mA.
b. Pilot positioner: The valve pneumatic actuator shall be equipped with an adjustable pilot positioner.

2. Steam trap(s):

a. Humidifier shall be provided with one float and thermostatic (F&T) trap for use with steam supply line.

3. Steam strainer(s):

a. Humidifier shall be provided with one wye strainer for use with steam supply line.

O. High-efficiency dispersion tubes:

1. Dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5.
2. Airstream heat gain shall not exceed values specified on the humidifier schedule; the values shall be supported by manufacturer's published data.
3. Insulating material shall meet the following criteria at 0.125" thickness:

a. Fire/smoke index shall be 0/0 per any of the following test procedures:

1) UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials)
2) NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials)
3) ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums)

b. Stable up to 300 °F continuous exposure.
c. Insulation shall not absorb water or support microbial growth .
d. Will not degrade when exposed to UVC light.
e. Continuous, seam-welded, and held in place without bands or clamps, to minimize surfaces for the accumulation of particulate matter.

P. Seismic Certification

1. Humidifier shall meet HCAI Special Seismic Pre-approval for building code CBC 2022 for duct and AHU applications.
2. Humidifier shall meet IBC 2022 Seismic Qualification for building code CBC 2022 for duct and AHU applications.

Q. Control Input Options

1. Humidistat, electronic, BACnet, room: Electronic humidistat, includes BACnet MSTP interoperability protocol, with internal sensor and modulating output (0-10 VDC or 4-20 mA) and touchscreen digital display showing both current humidity and humidity setpoint shall be wall-mounted. Accuracy to be +/-3% or better in operating range (0 to 90% RH and 32 to 122 F). 24 VAC/VDC power input required.
2. Airflow proving switch, pressure type: Airflow proving switch shall be diaphragm-operated with pitot tube for field installation. Switch shall have an adjustable control point range of 0.05" to 12" wc. Operating temperature range of -40 to 180 °F. Compatible with 24, 120, and 240 VAC.

## 2.17 DAMPERS

A. OA dampers shall be equal to TAMCO Model 9000 insulated dampers. Dampers shall be constructed of not less than 0.080” extruded aluminum frame, maximum 6” deep 0.060” extruded aluminum air-foil profile blades, internally insulated with expanded polyurethane foam (R-2.29) with thermal break construction. Blade seals shall be EPDM, secured in an integral slot within the aluminum blade extrusions. Frame seals shall be extruded silicone, secured in an integral slot within aluminum frame extrusions. Bearing shall be dual bearing system composed of a Celcon inner bearing fixed around a 7/16” aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in frame. Control shafts shall be 7/16” hexagonal zinc-plated steel. Linkage hardware shall be aluminum and corrosion-resistant zinc plated, and located outside airstream. Dampers shall be AMCA rated for Leakage Class 1A at 1” w.g. Damper actuators field provided and installed by ATC.

B. SA dampers shall be equal to TAMCO Model 1000 control dampers. Dampers shall be constructed of not less than 0.080” extruded aluminum frame, maximum 6” deep 0.060” extruded aluminum air-foil profile blades. Blade seals shall be EPDM, secured in an integral slot within the aluminum blade extrusions. Frame seals shall be extruded silicone, secured in an integral slot within aluminum frame extrusions. Bearing shall be dual bearing system composed of a Celcon inner bearing fixed around a 7/16” aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in frame. Control shafts shall be 7/16” hexagonal zinc-plated steel. Linkage hardware shall be aluminum and corrosion-resistant zinc plated, and located outside airstream. Dampers shall be AMCA rated for Leakage Class 1A at 1” w.g. Damper actuators field provided and installed by ATC.

C. Smoke dampers, where shown on the drawings, shall be TAMCO Model 1000 SM or equal. Construction shall be similar to the TAMCO 1000 control dampers.

D. Backdraft dampers for each fan shall be equal to TAMCO model 7600 CWA adjustable counterweighted heavy-duty damper. Backdraft dampers shall have extruded aluminum 0.080" frame and extruded 0.09" blades and engineered to produce minimum static pressure loss at the designed operating conditions. Seals shall be a dual system composed of Celcon inner bearing rotating within a polycarbonate outer bearing inserted in the frame. Hexagonal extruded aluminum 7/16" axles.

## 2.18 ELECTRICAL

A. Unit manufacturer shall furnish the 120-volt load components. All 120-volt components shall be field wired to terminate at a breaker panel/load center. Load center shall be NEMA 1, 3-wire, single phase, 240-volt max., 100A rated suitable for (12) single pole circuits.

B. Provide one vaporproof, LED light fixture per access section.

C. Provide 20A light switches and GFCI duplex receptacles where shown on drawings.

D. Unit manufacturer shall provide a 460V single point electrical panel, with main input disconnect switch. Enclosure shall be NEMA 1.

1. All wiring and conduit for "knocked-down" units shall be provided and installed by Electrical Contractor.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements

for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

F. After assembly of unit, unit manufacturer’s authorized field engineers shall perform a field casing leakage and deflection test of the completed cabinet assembly. Leakage and deflection shall meet the performance specified in Para. 1.3.B.

G. ATC devices and ductwork shall not be connected to unit until completion of the field leakage testing.

## 3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type L 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 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

## 3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

## 3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

## 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. 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, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
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.

## 3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

## 3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

## 3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

# SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Connectors and splices.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For solvents and adhesives, indicating VOC content.

C. Product Schedule: Indicate type, use, location, and termination locations.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 COPPER BUILDING WIRE

A. Description: Insulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.

## 2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.
2. AFC Cable Systems; Atkore International.
3. Hubbell Incorporated, Power Systems.
4. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

# PART 3 - EXECUTION

## 3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

2. Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

## 3.2 CONDUCTOR INSULATION CABLE APPLICATIONS AND WIRING METHODS

A. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

## 3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

## 3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

    a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.

2. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and

back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

## 3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

## 3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

## 3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly provide UL listed fire-proofing material,

## 3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements:

    a. Receptacles.
    b. Lighting Fixtures.
    c. Mechanical Equipment's.
    d. Lab Equipment's

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram, if applicable.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

# SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Hubbell Incorporated, Construction and Energy.
2. ERICO; nVent.
3. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
4. Siemens Industry, Inc., Energy Management Division.

## 2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

## 2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

a. Material: Die-cast zinc alloy.
b. Listed for direct burial.

# PART 3 - EXECUTION

## 3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

## 3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.
7. Armored cable runs.
8. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

## 3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

## 3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10ohms.
2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify NIH Project Officer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

# SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

A. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

## PART 3 - EXECUTION

### 3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101
2. NECA NEIS 102.
3. NECA NEIS 105.
4. NECA NEIS 111.

B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT and ERMC may be supported by openings through structure members, in accordance with NFPA 70.

3.3 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

# SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Fittings for conduit, tubing, and cable.
3. Metallic outlet boxes, device boxes, rings, and covers.
4. Termination boxes.
5. Cover plates for device boxes.

### 1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for all items specified under this section:

B. Sustainable Design Submittals:

1. Product Data: For solvents and adhesives, indicating VOC content.

## PART 2 - PRODUCTS

### 2.1 TYPE EMT-S RACEWAYS AND ELBOWS

A. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; Atkore International.
b. Calconduit; Atkore International.
c. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
d. Western Tube; Zekelman Industries.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 797 and UL Category Control Number FJMX.
2) Material: Steel.
3) Exterior Coating: Zinc.

4) Interior Coating: Zinc.
5) Colors: As indicated on Drawings.

2.2 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crouse-Hinds; Eaton, Electrical Sector.
b. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
c. Southwire Company.
d. Topaz Lighting & Electric.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514B and UL Category Control Number DWTT.
2) Material: Steel.
3) Coupling Method: Compression coupling.

c. Options:

1) Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
2) Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

B. Fittings for Type EMT Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; Atkore International.
b. Crouse-Hinds; Eaton, Electrical Sector.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Southwire Company.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514B and UL Category Control Number FKAV.
2) Material: Steel.
3) Coupling Method: Compression coupling.

c. Options:

1) Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
2) Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

## 2.3 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Metallic Outlet Boxes:

1. Description: Box having pry out openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crouse-Hinds; Eaton, Electrical Sector.
b. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Pass & Seymour; Legrand North America, LLC.
e. Wiremold; Legrand North America, LLC.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514A and UL Category Control Number QCIT.

c. Options:

1) Material: Sheet steel.
2) Sheet Metal Depth: Minimum 2.5 inch.

B. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crouse-Hinds; Eaton, Electrical Sector.
b. Killark; Hubbell Incorporated, Construction and Energy.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Pass & Seymour; Legrand North America, LLC.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514A and UL Category Control Number QCIT.

C. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crouse-Hinds; Eaton, Electrical Sector.
b. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514A and UL Category Control Number QCIT.

c. Options:

1) Material: Sheet steel.
2) Sheet Metal Depth: minimum 2.5 inch.

D. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.
b. Crouse-Hinds; Eaton, Electrical Sector.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

b. General Characteristics:

1) Reference Standards: UL 514A and UL Category Control Number QCIT.

## 2.4 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.
b. Metron; Hubbell Incorporated, Commercial and Industrial.
c. Square D; Schneider Electric USA.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 1773 and UL Category Control Number XCKT.
2) Listed and labeled for installation on line side of service equipment.

C. Indoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.
b. Killark; Hubbell Incorporated, Construction and Energy.
c. Siemens Industry, Inc., Building Technologies Division.
d. Square D; Schneider Electric USA.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL Category Control Number CYIV.

a) Non-Environmental Characteristics: UL 50.

b) Environmental Characteristics: UL 50E.

c. Options:

1) Degree of Protection: Type 1.

D. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Industrial Controls; Hubbell Incorporated, Commercial and Industrial.
b. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
c. Square D; Schneider Electric USA.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL Category Control Number BGUZ.

a) Non-Environmental Characteristics: UL 50.
b) Environmental Characteristics: UL 50E.

c. Options:

1) Degree of Protection: Type 1.

E. Indoor Sheet Metal Miscellaneous Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.
b. Hoffman; nVent.
c. Metron; Hubbell Incorporated, Commercial and Industrial.
d. Square D; Schneider Electric USA.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards:

a) UL 1773 and UL Category Control Number XCKT.
b) Non-Environmental Characteristics: UL 50.
c) Environmental Characteristics: UL 50E.

c. Options:

1) Degree of Protection: Type 1.

## 2.5 COVER PLATES FOR DEVICES BOXES

A. Metallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crouse-Hinds; Eaton, Electrical Sector.
b. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.
c. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:

1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
2) Wallplate-Securing Screws: Metal with head color to match wallplate finish.

c. Options:

1) Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
2) Wallplate Material: 0.032 inch thick Type 302/304 non-magnetic stainless steel with brushed finish.

# PART 3 - EXECUTION

## 3.1 SELECTION OF RACEWAYS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:
1. Concealed Conduit, Aboveground: EMT.

C. Indoors:
   1. Concealed in Ceilings and Interior Walls and Partitions: EMT.

D. Stub-ups to Above Recessed Ceilings: Provide EMT for raceways.

## 3.2 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult NIH Project Officer for resolution of conflicting requirements.

B. Degree of Protection:

   1. Indoors:

      a. Type 1 unless otherwise indicated.

## 3.3 INSTALLATION OF RACEWAYS

A. Installation Standards:

   1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult NIH Project Officer for resolution of conflicting requirements.
   2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
   3. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
   4. Comply with NECA NEIS 101 for installation of steel raceways.
   5. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
   6. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch trade size and insulated throat metal bushings on 1-1/2 inch trade size and larger conduits terminated with locknuts.
   7. Raceway Terminations at Locations Subject to Moisture or Vibration:

B. General Requirements for Installation of Raceways:

   1. Complete raceway installation before starting conductor installation.
   2. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
   3. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
   4. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

5. Support conduit within 12 inch of enclosures to which attached.
6. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
7. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

8. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
9. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
10. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
11. Cut conduit perpendicular to the length. For conduits 2 inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
12. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire.

C. Requirements for Installation of Specific Raceway Types:

1. Types ERMC and IMC:

    a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

## 3.4 INSTALLATION OF BOXES AND ENCLOSURES

A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

D. Locate boxes so that cover or plate will not span different building finishes.

E. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.

F. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.

G. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.

H. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.

I. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.

J. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
2. Provide gaskets for wallplates and covers.

## 3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies provide UL listed.

## 3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

## 3.7 CLEANING

A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 260533

# SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

1. Color shall be factory applied[ or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

4. Color for Neutral: White or gray.
5. Color for Equipment Grounds: Green.
6. For larger-sized conductors, provide appropriate color tape minimum 6in. wide around the conductor of multiconductor cable in the same manner as the single conductor.

C. For all control system wiring, provide permanent, numbered tape markers at both ends of the of the cable, and splice points of each conductor. Tape marks shall be uniform in color.

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs if applicable shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification Labels:

1. Black letters on a white field.

## 2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Marking Services, Inc.
e. Panduit Corp.
f. Seton Identification Products; a Brady Corporation company.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Marking Services, Inc.
c. Panduit Corp.
d. Seton Identification Products; a Brady Corporation company.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. emedco.
c. Ideal Industries, Inc.
d. Marking Services, Inc.
e. Panduit Corp.
f. Seton Identification Products; a Brady Corporation company.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels:

    a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
    b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Brady Corporation.
    b. HellermannTyton.
    c. Marking Services, Inc.
    d. Panduit Corp.

2. Minimum Nominal Size:

    a. 1-1/2 by 6 inches for raceway and conductors.
    b. 3-1/2 by 5 inches for equipment.
    c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Brady Corporation.
    b. HellermannTyton.
    c. Marking Services, Inc.
    d. Panduit Corp.

## 2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlton Industries, LP.
    b. Champion America.
    c. HellermannTyton.
    d. Ideal Industries, Inc.
    e. Marking Services, Inc.

f. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. HellermannTyton.
b. LEM Products Inc.
c. Marking Services, Inc.
d. Seton Identification Products; a Brady Corporation company.

## 2.6 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

## 3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

J. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

K. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

L. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

M. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

N. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

P. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

Q. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

R. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

S. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

T. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

U. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

V. Cable Ties: General purpose, for attaching tags, except as listed below:

1. In Spaces Handling Environmental Air: Plenum rated.

## 3.3 IDENTIFICATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

H. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

I. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

K. Operating Instruction Signs: Self-adhesive labels.

L. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Emergency system boxes and enclosures.
e. Enclosed switches.
f. Enclosed circuit breakers.
g. Enclosed controllers.
h. Receptacles, Lighting Switches, Junction Boxes and Pull Boxes.

END OF SECTION 260553

# SECTION 260800 - ELECTRICAL COMMISSIONING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Start-up.
2. Commissioning.

B. Related Sections:

1. Supplementary Conditions Section.
2. Division 01 – General Commissioning.

### 1.2 DESCRIPTION OF WORK

A. This Section includes Fundamental Commissioning (Cx) work related to start-up procedures and the commissioning procedures related to systems installation and start-up. This section also includes a description of the duties of the Commissioning Authority (CxA) and contractor as they relate to start-up as well as other phases of electrical work.

B. The activities called for in this Section apply to;

1. Electrical controls power, power systems, and work called for by Division 26.

C. Refer to other Division 26 Sections of the Specifications for start-up procedures for any other building systems included in this scope of work.

D. The Owner has contracted directly for all the duties and responsibilities required herein for the Commissioning Authority.

1. The Contractor shall include the commissioning activities in the master construction schedule.

E. The Contractor shall include the commissioning activities in the master construction schedule.

### 1.3 DEFINITIONS

A. Commissioning: Commissioning is a systematic process that addresses the communication and coordination between the Owner, design team, and construction team. Commissioning will ensure the installation and verification interaction of the components and systems for the specified operating conditions of the electrical systems in the facility. The CxA works closely with the Owner, design and construction team to ensure a smooth commissioning process. The procedures used to assist the Owner and the Design Professional in monitoring the installation of and facilitating the successful start-up of the building systems verifying their installation

performs as designed and specified, assisting with the permanent transfer of the operation and maintenance responsibilities of the electrical systems to the Owner and the Owner's operating personnel. The installation is then "officially" placed into service and becomes the property of the Owner. Commissioning assists in the coordination of construction schedules and sequences to facilitate an efficient construction process. Commissioning serves the Owner's best interests by delivering a facility with systems that perform as specified, intended, and paid for.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This is an overall plan that provides the structure, schedule, and coordination planning for commissioning. As construction progresses, the CxA will update the plan, which includes details of:

1. Commissioning scope.
2. General project info.
3. Systems to be commissioned.
4. Rigor of commissioning.
5. Team contact information.
6. Roles and responsibilities of all parties.
7. Communication and reporting protocols.
8. Commissioning overview and details of submittal activities.
9. Construction observation, checklists, and start-up activities.
10. Process for dealing with deficiencies.
11. Test procedure development and execution.
12. Operation and maintenance (O&M) manual review.
13. Warranty period activities
14. Operation training procedures witness applicable Contractor training on-site activities.
15. Systems manual development.
16. Description of summary report, progress, and reporting logs.

C. Commissioning Authority (CxA): Retained by the Owner, the commissioning authority acts as the Owner's advocate, and leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

E. Pre-functional Checklists: Pre-functional checklists are forms developed by the contractor, equipment manufacturer, or CxA as applicable and used by the contractor to verify that specified systems and components are complete and correctly installed, ready for start-up and functional testing. These Checklists are supplemental to the equipment manufacturer's standard installation instructions and pre-start up forms. The Completed Checklists along with the equipment manufacturer's pre-start-up forms must be submitted by the contractor PRIOR to start-up of the equipment. Equipment specified to have factory start-up performed must have the applicable Checklist filled out by the vendor and submitted by the contractor. After the Checklists have been approved and start-up has occurred, the contractor can begin their pre-checkout of the functional operations of the equipment and systems prior to validation by the CxA during the Functional Testing.

F. Start-Up: The initial activation or energizing of equipment's or systems for the purpose of demonstrating completeness of installation, utility connections, performance, system operations, and ability to perform for its specified purpose.

G. Prefunctional Testing: The process of starting the equipment and systems utilizing vendor/contractor startup and installation checklists approved by the CxA for pre-functional documentation to ensure systems are ready for start-up and initial operation in compliance with the contract documents, specifications and building automation system sequences, prior to functional validation in the Acceptance testing phase by the CxA. Prefunctional testing includes the Contractor's successful completion of pre-testing of all systems to be commissioned based on the approved CxA's FPTs. This is the pre-requisite for the Contractor's submission of the Certificate of Readiness letter.

H. "Certificate of Readiness" letter: Contractor letter to be submitted to the CxA indicating all systems have been pre-tested successful and are ready for scheduling and execution of the CxA Functional Performance Testing.

I. Systems Manual: The systems manual includes the operation manual, maintenance manual, and additional information of use to the owner during occupancy and operations. This manual expands the scope of traditional operating and maintenance manuals to include other project information such as plans and specifications, approved submittals, operating and optimization procedures, training / commissioning records, and additional information developed and gathered during commissioning.

J. Functional Performance Test (FPT) Procedures: This written protocol defines methods, personnel, and expectations for test conducted on components, equipment, assemblies, systems, and interfaces among systems. Tests clearly described the test prerequisites, required test conditions, individual systematic test procedures, expected system response and acceptance criteria for each procedure, actual response or findings, and any pertinent discussion. Test procedures differ from testing requirements found in the specifications, which describe what modes and features are to be tested and verified and under what conditions. Test procedures describe the step-by-step method of how to test. Simple checklists may be appropriate for testing simple components, but dynamic testing of interfacing components requires more detailed procedures and forms.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Except for the activities to be performed by the CxA called for herein, all component and system installation work required by the Division 26 specifications including specific contractor furnished items indicated by this Section shall be provided by the Contractor.

B. The Contractor shall provide all necessary manpower to assist the CxA in his activities to access all equipment and components including providing ladders with personnel to remove and re-install ceiling tiles under equipment to be commissioned and providing door keys to access rooms throughout the building.

C. The Contractor shall perform and verify in writing that their "in-house" preliminary commissioning and start-up based on equipment manufacturers submitted procedures and FPT's

have been tested to assure to the CxA that the systems, equipment, and components are ready to be commissioned and to inform the CxA that his start-up activities can begin. The contractor shall perform a prefunctional checkout and pre-testing of the power systems to verify functional sequences are complete prior to commencing the functional systems validation by the CxA. After completion of the prefunctional checkout, they demonstrate to the CxA that the systems operate as specified and complete. If the sequences are found to require minor modifications, based on actual field conditions, the contractor and CxA shall jointly prepare recommendations and submit to the Owner/Design Professional of Record for approval, prior to modifications.

D. The Contractor shall perform that the detailed "point to point" checkouts to verify that all system low voltage and communication wiring and any associated hard-wired interlocks are correct PRIOR to the commissioning acceptance testing activities by the CxA. Upon this completion by the Contractor, the Contractor shall work through the Sequence of Operation pre-testing activities using the approved CxA FPT test scripts to verify that the operations meet the intent of the specifications and the FPT test scripts. If sequences are found to require minor modifications based on actual field conditions, the Contractor and CxA shall jointly prepare recommendations and submit to the Owner and Design Professional of Record for his approval of the modifications. Once all pre-testing has been successfully completed, the Contractor shall verify in writing via submission of a "Certificate of Readiness" letter indicating all systems have been pre-tested successful and are ready for scheduling and execution of the CxA Functional Performance Testing.

E. The CxA will assist in the review of the electrical equipment submittals along with the Design Professionals for the Division 26 submittals of equipment/systems to be commissioned called for by the Contract Documents. The CxA review shall coincide or proceed after the Engineer's submittal review documents comments have been issued. The CxA review is NOT part of the Submittal Approval as this is the responsibility of the Design Professional. The CxA review comments are considered as recommendations and suggestions based on the CxA interpretation of the Design Documents and are for review by the Design Professional for possible implementation.

## 3.2 COMMISSIONED EQUIPMENT/SYSTEMS

A. Electrical Systems:

1. Electrical Systems & Equipment

## 3.3 START-UP

A. Place each item of equipment and each system into full operation.

B. Prior to start-Up:

1. The CxA shall verify that equipment and systems are complete, correctly connected to utilities, and tested. The CxA will submit to Owner, the Contractor and Design Professional Commissioning "Site Reports" and "Cx Issues Log Reports" indicating any deficiencies in the installation relating to the commissioned equipment and component connections, maintenance clearances for servicing components and removal/replacement of equipment, code required clearances, hanger suspension of

equipment and components, etc. A detailed "Cx Issues Log Report" will be maintained throughout the construction process and updated on a timely basis for the team.
2. Comply with requirements of manufacturers.
3. Perform all pre-start inspections and tests as called for in the electrical Division 26 for the systems to be commissioned including all equipment and as may be necessary to ensure that work is installed as specified and to determine suitability for energizing.
4. The Contractor shall provide power for start-up and testing as may be required by the CxA.
5. The Contractor shall arrange for a change over from temporary to permanent utility sources.
6. The Contractor shall complete all Pre-functional checklist (PFCs) forms for the equipment to be commissioned and submit to the CxA for approval so start-up can begin.
7. When specified or when required by manufacturer, have manufacturer's representative perform start-up and supervise their activities.

C. Notify the CxA / Architect / Engineer a minimum of five (5) days prior to start-up of each item and system.

D. The CxA start-up and testing of major power system/equipment and components specified herein and in the electrical Division 26, shall take place with the assistance of the Contractor as required. Power shall be provided by the contractor as required, scheduled a minimum of 5-day advance notice.

E. Execute start-up under supervision of qualified contractor and equipment manufacturer personnel and in accordance with the manufacturer's instruction.

1. The CxA shall review the equipment manufacturer's prefunctional checklist for completion. The CxA may add to this checklist any requirements that go beyond the startup and installation checklists, which must be acknowledged before demonstration of the functional tests occur.
2. When specified or when required by manufacturer, have manufacturer's representative perform start-up witnessed by the CxA.
3. Review the manufacturer's representative written report of start-up operation and include in the Commissioning Report.

F. After start-up, the CxA shall notify the Contractor of any "punch-list" items requiring correction such as adjustments to components and equipment, any systems operation, equipment clearances for maintenance and code compliance, connections for: controls, etc.

G. The CxA shall perform with the Contractor assistance and manpower support component and system testing checking through every function and control sequence/cycle to ensure that it operates as designed and specified by conducting field observations for verification of the status of operation.

H. The CxA shall confirm the operation of equipment and systems documenting the results in the Commissioning Report and submit this to the Owner/Design Professional for review.

1. The Contractor shall have the final version of the Operating and Maintenance manuals specified in the Electrical Division 26 for power systems available a minimum of four (4) weeks prior to acceptance testing and demonstration for components and systems.

## 3.4 CXA ACTIVITIES

A. Assist the Design Professional in verifying and documenting compliance with the contract documents.

B. Review the construction drawings and specifications for Electrical Division 26 for commissioning requirements and prepare written comments indicating design recommendations which will provide for a proper commissioning process by the Cx team (Contractor and CxA).

C. The Architect will forward to the CxA approved equipment submittals (including O&M Manuals) reviewed by the Design Professional, review and affix a review stamp of components to be commissioned for use by the CxA for preparing Pre-Functional Checklist forms and Functional Performance Test Procedure forms (FPT's).

D. Oversee the performance of the start-up and functional tests of equipment, systems and components working with the Contractor for the sequences of operation.

E. Review the Contractor's instructions contained in the submittal of the Operation and Maintenance manuals having procedures given to the Owner's operating and maintenance personnel 2 weeks prior to the Contractor conducting the training classes. The CxA shall review the Contractor's material for the training classes given to the Owner. The CxA shall review and approve the Contractor's Training Program documentation prior to the start of the Training Classes and enhance the program as required with any commissioning requirements of benefit to the Owner. This Training Program shall include how the training will be conducted; when and where the sessions will be held; names and company affiliations of trainers; recommended reference materials; outside reading, etc.

F. Observe installed electrical power, devices, controls, and equipment prior to covering or ceiling and partition installation. Contractor shall coordinate with the CxA a minimum of 7 days in advance for CxA site observation scheduling, then follow up 3 days prior for confirmation of date for CxA site review.

G. Make periodic site visits during equipment and system "rough-in" to review their installation with particular attention paid to proper access for maintenance, code required clearances, etc. Document these findings in Commissioning "Site Reports" and "Cx Issues Log Reports" as "punch-list" items requiring correction by the Contractor.

H. Coordinate with the Contractor's construction schedule for implementation of the Commissioning Activities after reviewing the overall general construction schedule. Coordinate updates to the Commissioning Activities with the Contractor throughout the construction of the project.

I. Witness a sample of design and performance control systems tests called for by the Electrical Division 26. Initiate and witness additional system and equipment tests as required to verify compliance and performance.

J. Monitor the installation of all major electrical equipment to be commissioned.

K. Attend site observations for substantial and final completion and assist in listing (punch list) the incomplete or corrective work called for.

L. Review the fabrication, installation and storage procedures of all equipment and materials to be commissioned, equipment and shop fabricated items, in the field as well as at the subcontractor's shop, and at the shop of any sub-sub-contractors or suppliers.

M. Review all changes in scope that affect the systems to be installed related to Electrical Division 26 and adjust the Commissioning Plan as required.

N. Review the Contractor's installed equipment identification and labeling for conformance to the specifications.

O. Coordinate the start-up with the Owner so that their staff can be present during the commissioning start-up and system testing activities.

P. Prepare and submit the Final Commissioning Report prior to project acceptance by the Owner. The report shall consist of the following:

1. Cx Summary Report with Executive Summary.
2. Final Cx Plan
3. Final Cx Design Review Log
4. Cx Submittal Reviews
5. Contractor completed PFCs
6. Cx Site Reports
7. Cx Issues Log Reports of punch list items.
8. Completed Equipment Start-up Report Forms (from the contractor).
9. Manufacturer Start-up Reports (from the contractor).
10. Testing Log reports (from the contractor).
11. Completed Functional Performance Test forms (FPT's).
12. Training Acceptance – Training Completion log and Contractor's certificate that all training has been completed and accepted by the owner.

Q. Occupancy and Warranty Phase: Commissioning during the Occupancy and Warranty period is intended to assist Ga Gwinnett College facility operating staff in identifying any defects in the installed equipment or system operation.

1. Review Contractor's agenda for training to Owner. Witness Contractor provided systems training on
2. Conduct a 10-Month site visit to review the current building operation with staff and review outstand Review with facility staff any problems or concerns they have with operating the building as originally intended.
3. Update the Cx Issues Log and track resolution.
4. Update the final commissioning report (update the Commissioning Summary Report for all Warranty
5. Complete applicable LEED Cx templates for commissioning activities for the required LEED Certifi

## 3.5 CXA – SCHEDULE OF ACTIVITIES

A. Within a timely fashion after the Notice to proceed, the CxA shall submit to the Contractor a schedule of the construction activities related to the work of Electrical Division 26, as called for by the Contract Documents, which the CxA will be inspecting, monitoring or performing, including the name of the person who will be performing the Activities. Periodic updates will be submitted during the course of the project to keep the Contractor current with any modifications to Contractor's construction schedule and the Schedule of Activities.

B. Prior to the beginning of any major electrical systems field work, the CxA will forward to the Owner/ Design Professional and the Contractor copies of the applicable "Prefunctional Checklist" forms to be executed by the CxA with the assistance of the Contractor's field personnel.

C. The CxA shall prepare and distribute functional test procedures for completion by the CxA. These documents will be used during completion of the prefunctional tests and during the CxA validation process to confirm systems are complete and operational.

## 3.6 CONTRACTOR RESPONSIBILITIES – CXA ACTIVITIES

A. Contractor shall accommodate the duties and tasks of the CxA, including, but not limited to, by:

1. Allowing the CxA access to the site during normal working hours.
2. Working with the CxA to coordinate commissioning activities with construction activities and include these activities in the master construction schedule. This master construction schedule shall include a minimum of one (1) week of schedule time for the commissioning activities PRIOR to project turnover to the Owner for "final" building systems acceptance.
3. Making allowance in the overall project schedule for the integration of those commissioning activities which are dependent upon the activities and progress of the project. Allow a minimum of seven (7) days from the start-up of the last unit in the system until the completion of the Commissioning process.
4. Including the CxA on project correspondence distribution for Construction Schedule updates along with mechanical and plumbing systems coordination items sent to the Design Professional.
5. Notifying the CxA directly with a copy to the Architect, of any procedure, test, covering, installation, or start-up of equipment, which are on the Schedule of Activities.
6. Contractor shall inform the CxA of the schedule of his performance for all tests for electrical power systems, components, and equipment to be commissioned. The contractor shall perform his own "Point-to-point" wiring and detailed field testing to assure all Power Controls are functioning properly PRIOR to the CxA Functional Testing activities. The contractor shall assist the CxA in the field providing labor as required to operate the power systems during the Functional Testing of all electrical equipment and components.
7. After completion of all pre-testing of the system, submit "Certificate of Readiness" for verifying the mechanical and plumbing equipment/systems have been successfully pre-tested and functioning as intended by the design intent and the approved CxA Functional Performance Test scripts (FPTs). The schedule for CxA Functional Testing with the construction team will be coordinated and set with the Contractor after receipt of this Certificate. Allowance in the schedule shall be provided for the time between the submission of this Certificate and the actual start date for the field CxA testing.
8. The Contractor shall respond in writing within seven (7) days to the Commissioning "Site Reports" and "Cx Issues Log Reports" with dates of completion of the associated punch list items noted by the CxA.
9. The Contractor shall provide power and fuel for start-up and testing as may be required by the CxA and other sections of the specifications.
10. The Contractor shall arrange for a change over from temporary to permanent utility sources.

11. Where specified or when required by manufacturer, the Contractor shall have the manufacturer's representative perform start-up to be supervised by the CxA for their activities.
12. Refer to paragraph 3.1 above for additional Contractor requirements.
13. Complete Pre-functional checklists and start-up reports and submit to the CxA in advance to starting the pre-testing. After pre-testing has been completed, submit the Certificate of Readiness a minimum of one (1) week prior to the start of the CxA Acceptance Testing Phase which will be at least two (2) weeks before building turnover to the Owner.
14. Attend a ten (10) month warranty site meeting to review any outstanding Cx Issues Log items required for completion.

B. The Contractor's construction schedule shall be the basis for the coordination of the CxA activities. Input from the CxA shall not be used or construed to dictate the progress, timing or planning of any of the Contractor's work activities except as necessary to coordinate the CxA scheduled activities. Contractor shall issue their updated Construction Schedule to the CxA when these are issued to the Owner and Design Team

C. Contractor shall provide a minimum of seven (7) days written notice in advance of any test, cover-up, installation or scheduled commissioning activity. Failure to provide this notice may result in the Contractor uncovering, re-testing or re-starting these systems at the Contractor's expense. The CxA will coordinate in an efficient manner to work with the Contractor to assist in maintain the project construction schedule as much as possible for an efficient Cx Process.

D. The Contractor shall, at all times and upon demand, make available to the Architect and the CxA for inspection, the Record Drawings maintained in the field called for by the General Conditions, all currently approved Shop Drawings, and the current version of the Operation and Maintenance manuals.

E. The Contractor shall coordinate and make arrangements for a collaborative effort between the CxA and the controls sub-subcontractor or electrical contractor (if any) to perform functional tests on each item, sub-system and entire system witnessed by the CxA. Additional systems as noted herein will require the Contractor's assistance in field personnel along with providing access to ceiling plenums and rooms (providing labor to remove/reinstall ceiling tiles, ladders, etc.).

F. Contractor shall make provisions for and shall accommodate the services to be performed.

G. The Contractor shall schedule the Work taking into account the activities to be performed by the CxA. No claim for delay or request for an extension of Contract Time will be allowed as the result of the scheduled activities of the CxA.

H. The Contractor shall take into account the activities of the CxA in submitting their Bid for the Work. No additional compensation or changes in the Contract Sum will be approved if the basis of the proposed change is a result of the prescribed activities of the CxA.

I. The Contractor shall conduct training classes and coordinate with the CxA for his approval of the training materials and the Owner for his staff participation. All Training Classes should be recorded on videotape and two copies of the tapes should be furnished to the Owner for use to train future staff. The Contractor shall provide to the CxA the Training Completion Log listing

all training sessions and the approved training completion forms signed by the Owner. The training shall include as a minimum the following:

1. The Training Classes shall be provided for all equipment as required by Division 26 specifications.
2. The Contractor shall have factory specialists for power equipment and systems present their specific training to the Owner.
3. The Contractor shall prepare the Training Program documentation prior to the start of the Training Classes and forward a copy of it to the Commissioning for inclusion of any necessary commissioning requirements that will be benefit to the Owner. The Agenda and Program shall include all systems installed along with a walk-thru of through of the building, start-up procedures and emergency actions, shut-down procedures, maintenance schedules and requirements, warranties, and call procedures during and after warranties expire, spare parts and sources, and tools/troubleshooting.
4. Contractor shall submit Training Completion documentation to the CxA after completion of all training. This information shall include: systems trained, date of training, all attending parties and Owner sign-off acknowledgement of acceptance of training activities.

END OF SECTION 260800

# SECTION 26 2726 - WIRING DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. GFCI receptacles, 125 V, 20 A.
   2. Wall plates.

### 1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

### 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

### 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.

H. Wall Plate Color: Stainless steel, brushed aluminum.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A :

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper Wiring Devices, Inc.
   b. Hubbell Incorporated; Wiring Devices-Kellems.
   c. Leviton Manufacturing Co. Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.

## 2.4 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Antimicrobial Cover Plates:

1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Tarnish resistant.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Provide terminations, adapters, boxes, and other fittings required for the installation.

C. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and support.

E. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.
5. Adjust locations of multi-outlet assemblies to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
6. Provide outlets with special requirements, such as GFCI, AFCI, or special environmental requirements, where required by Drawings or to meet codes.

F. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

G. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

H. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

I. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

## 3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

## 3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

## 3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. In healthcare facilities, prepare reports that comply with NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

F. Wiring device will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 262726

# SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Molded-case circuit breakers (MCCBs).
   2. Enclosures.

### 1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## 1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

## 1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

## 1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.

F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

G. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

## 2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

C. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

### 3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify NIH Project Officer no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without NIH Project Officer’s written permission.
4. Comply with NFPA 70E.

### 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

### 3.4 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with NFPA 70 and NECA 1.

## 3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

## 3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer. Retain first option in paragraph below if the indicated Section is included in the Contract Documents. Retain second option and include settings on the

Drawings or in a schedule attached to this Section if indicated Section is not included in the Contract Documents.

END OF SECTION 262816

# SECTION 262923 - VARIABLE-FREQUENCY DRIVES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

### 1.3 DEFINITIONS

A. BAS: Building automation system.

B. CPT: Control power transformer.

C. EMI: Electromagnetic interference.

D. IGBT: Insulated-gate bipolar transistor.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of common coupling.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. TDD: Total demand (harmonic current) distortion.

P. THD(V): Total harmonic voltage demand.

Q. VFD: Variable-frequency motor controller.

R. VFD: Variable-frequency drive (synonymous with VFD).

1.4 SUBMITTALS

A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of enclosed unit.
f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD (V) at each VFD at the defined PCC to specified levels.

1. Harmonic Calculations: The VFD manufacturer shall supply harmonic calculations made in accordance with the latest version of IEEE 519 showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. System single-line, 480V transformer data, generator data and primary fault current data can be found in the Overcurrent Protective Device Coordination Study and can be obtained from the Electrical Contractor. The calculations shall include:

a. All input data and assumptions
b. Explanation of method used to perform the analysis
c. All calculations and computer printouts used in the analysis, including input documentation

d. A system impedance diagram based on Electrical single-line diagram
e. All calculations shall be made in accordance with IEEE 519 with all drives at 100% speed. The point of common coupling shall be the secondary connection of the transformer supplying that group of devices. These calculations shall be done with the transformer loaded to no more than 70% of its nominal capacity. These calculations shall also be done with all 12-pulse or greater drives running as well as the smaller drives running.
f. A detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the THD limits.

    1) The description shall include information on the proposed test equipment and test conditions.
    2) Include the name and qualifications of the firm which will conduct the field test.

g. Each point of common coupling shall be defined as the secondary of the side of the transformer that feeds that group of drives. At the point of common coupling, the following numbers shall meet with the maximum load on the transformer no greater than 70% of its nominal capacity.

    1) Total harmonic voltage distortion is less than 3%
    2) Total harmonic current distortion is less than 5% and harmonic table requirements $I_{sc}/I_L<20$.

    Note: 6-Pulse drives will not be accepted for over 175hp drives, even if this calculation is met.

h. Submittals without calculations will not be reviewed

E. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements including raceway stub-ups and field wiring. Show support locations, type of support, and weight on each support. Indicate field measurements.

F. Qualification Data: For qualified testing agency.

G. Product Certificates: For each VFD, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.

4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

K. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

L. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller

## 1.7 PROJECT CONDITIONS

A. Environmental and Operating Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than $0^0$F and not exceeding $120^0$F.
2. Ambient Storage Temperature: Not less than minus $4^0$F and not exceeding $140^0$F
3. Humidity: Less than 95 percent (noncondensing and non-corrosive).
4. Altitude: Not exceeding 3300 feet.
5. Incoming 3-phase 480 VAC power: +5% or -10% at 60 Hz.
6. A 50% voltage sags for 30 cycles.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect no fewer than 10 days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.

3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

## 1.8 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

D. Submit written, signed off coordination statement confirming input control signal is compatible with automatic controls and/or building automation control system.

## 1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## 1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 5 percent of quantity installed for each size and type, but no less than one of each size and type.
2. Control Power Fuses: Equal to 5 percent of quantity installed for each size and type, but no less than 1 of each size and type.
3. Indicating Lights: 1 of each type and color installed.
4. Auxiliary Contacts: Furnish 1 spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish 1 spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with ANSI, IEEE and NEMA requirements, provide products by one of the following:

1. ABB (Advanced Thermal Solutions @410-247-7901).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit (Sheppard Electric @410-866-6000).
3. Robicon (Shepherd Electric @410-866-6000).

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C

C. Application: Constant torque and variable torque.

D. VFD Description: Variable-frequency power converter (PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. The VFD shall convert the fixed voltage and frequency available from the utility or campus wide system to a variable voltage and frequency output via a 2-step operation. VFD's utilizing a third power section will not be acceptable. Efficiency shall exceed 95% at 100% speed and load. Line side displacement power factor shall exceed 0.95 regardless of speed and load. The VFD shall be rated for 110% current for 1 minute for variable torque loads and 150% current for 1 minute for constant torque loads.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than $14^0$F and not exceeding $120^0$F.
8. Ambient Storage Temperature Rating: Not less than minus $4^0$F and not exceeding $140^0$F.
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 5 percent.
15. Output Carrier Frequency: Selectable; 0.5 to 15kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
17. VFD's above 200hp: 12-Pulse, THVD < 5%, THCD<8% & harmonic table requirements for $I_{sc}/I_L$ =20-50, THD=8.0.
18. VFD's 200hp and Less: 6-Pulse, THVD<5%, THCD<8% & harmonic table requirements for $I_{sc}/I_L$ <20, THD=5.0%.

H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.
2. Signal: Pneumatic.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Current Limit: 30 to minimum of 150 percent of maximum rating.
4. Minimum frequency (4-60 Hz)
5. Maximum frequency (40-120 Hz)
6. Four preset speeds (4-120 Hz) initiated by contact closures
7. Four acceleration times (2-300 seconds)
8. Four de-acceleration times (2-300 seconds)
9. Minimum speed dwell time (0-18 seconds)
10. Voltage boost (0-40V) for starting torque control
11. Adjustable Carrier Frequency (700-10,000 Hz) for motor noise reduction or flexible switching technology. This adjustment shall be without derating the drive or motor.
12. Current Limit (70-120%)Critical Frequency Avoidance (2 bands with 10 Hz adjustable widths

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with 3 selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC alarm contact that operates only when circuit breaker has tripped.

## 2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.

5. Overcurrent.
6. External fault.
7. Run/Stop selection and LED indication (keypad or remote)
8. Speed control selection and LED indication
9. Forward/Reverse selection
10. Manual speed adjustment
11. Frequency meter
12. Motor RPM
13. Ammeter
14. Output Voltage
15. Elapse Time Meter

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last 4 faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. A minimum of 2 programmable analog inputs: 4- to 20-mA dc.
b. A minimum of 6 multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 to 1**5** psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

a. RS485
b. Keypad display for local hand operation.
c. 0- to 10-V dc.
d. 4- to 20-mA dc.
e. Potentiometer using up/down digital inputs.
f. Fixed frequencies using digital inputs.

4. Output Signal Interface: A minimum of 2 programmable analog output signal(s) 4- to 20-mA dc, which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

5. Remote Indication Interface: A minimum of 2 programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status, alarm and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: RS-/485.
2. Embedded BAS Protocols for Network Communications:

## 2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. Input Line Conditioning:

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2

## 2.4 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

D. In "Bypass Contactor" Subparagraph below, IEC-rated contactors are most often used for the bypass contactor in HVAC applications and for smaller motors, and they are usually smaller and less costly than equivalent NEMA-rated contactors. NEMA-rated contactors are most often used in industrial applications and for larger motors, where they must carry high motor inrush and full-load running currents. IEC-rated contactors are most often used in all applications for the isolating contactors, because they are only used to isolate the power converter and normally do not carry any current.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode

1. Bypass Contactor: Load-break, NEME-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

F. Bypass Contactor Configuration: Full-voltage (across-the-line).

1. HAND/OFF/AUTO selector switch.
2. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
3. Contactor Coils: Pressure-encapsulated type

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
c. Control Circuits: 24ac; obtained from integral CPT, with primary and secondary fuses of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. The CPT shall be a constant-voltage control power transformer. CPT Spare Capacity: 100> VA.

4. Overload Relays: NEMA ICS 2.

a. Melting-Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

b. Bimetallic Overload Relays:

1) Inverse-time-current characteristic.
2) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
3) Ambient compensated.
4) Automatic resetting.

c. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
4) Analog communication module.

d. NC isolated overload alarm contact.
e. External overload reset push button.

## 2.5 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 4X non-metallic.
3. Other Wet or Damp Indoor Locations: Type 4X non-metallic.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
5. Mechanical and Electrical Rooms: NEMA Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.6 ACCESSORIES Match to Enclosed Controllers

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.

a. Push Buttons: Covered Lockabletypes; momentary
b. Pilot Lights LED types; Green for de-energized state, red for energized state, amber for warning and white for alarm ; push to test.
c. Selector Switches: Rotary type.
d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. NC bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

I. Spare control-wiring terminal blocks wired.

J. Control Power Ride-Through Capability: Provide constant voltage control power transformer or other means to ensure drive can withstand a minimum voltage dip/sag for up to 0.5 seconds. This includes all contactors, relays, etc.

K. Wiring Access Option: Coordinate with installer and select the correct wiring access panel option (i.e., top or bottom) for each VFD enclosure.

L. A Customer Interlock Terminal Strip – Provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. All external interlocks and strat/stop contacts shall function with drive in hand, auto or bypass.

M. Output Line Reactors or Filters: Provide when the drive is separated from the motor by more than 50 feet.

N. Door Interlock Circuit Breaker rated at 65,000 AIC with 5% total line impedance.

O. Thermal motor overcurrent relay.

## 2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2

1. Test each VFD while connected to its specified motor .
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD (V) at each VFD at the defined PCC to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

## 3.3 INSTALLATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

## 3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

## 3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and the building automation system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

## 3.6 FACTORY TESTS AND CHECKS

A. VFD power semiconductors and diodes shall be 100% inspected and tested, including load testing.

B. Small signal semiconductors, resistors, capacitors and diodes shall be lot sampled. Testing shall include parameter, as well as, functional characteristics.

C. All printed circuit-boards shall be tested under a temperature cycling ($0^0$C to $+65^0$C) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.

D. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.

E. After all tests have been performed, each VFD shall undergo a 24-hour burn-in test. The drive shall be burned-in at 100% inductive or motor load for 24hours without an unscheduled shutdown.

F. After the burn-in cycle is complete, each VFD shall be provided by the manufacturer upon request prior to shipment.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to direct testing.

2. Testing, checkout and startup of the VFD equipment shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
3. The contractor shall provide independent harmonic testing by an independent testing company. Readings with printouts of the harmonic current at each harmonic, as well as, the total voltage distortion. The following readings shall be provided:

    a. At each point of common coupling:

        1) With all drives running with load
        2) With all drives off

    b. At the power connection to each drive:

        1) With the drive running loaded
        2) With drive off

    c. All the above data shall be submitted to the Owner for review. If these tests show the drives are not in compliance with the specifications, the drive manufacturer shall make all changes required to comply with the specifications at no cost to the Owner. If required, this could mean replacing the drives that are not in compliance.
    d. A copy of all the tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFD 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFD’s will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

## 3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

## 3.9 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed

D. eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maxim

E. um settings do not allow starting of a motor, notify Owner before increasing settings.

F. Set the taps on reduced-voltage autotransformer controllers.

G. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

H. Set field-adjustable pressure switches.

## 3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

C. The VFD shall be protected against damage at all times. The drive shall be stored in a clean, dry environment with temperatures and humidity within the range specified by the drive manufacturer. Space heaters shall be energized controlled storage as recommended by the manufacturer. Storage space shall be environmentally controlled.

## 3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 262923




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