



University of Colorado  
Anschutz Medical Campus

Fitzsimons Building Heating Improvement  
Phase 2

Project Number (21-174018)

## **PROJECT MANUAL**

Issue for Bid

December 9, 2022



The RMH Group  
12600 W Colfax Ave A-400  
20607

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### DIVISION 01 – GENERAL REQUIREMENTS

Section	Title
01 00 00	General Requirements
01 10 00	Summary
01 25 00	Substitution Procedures
01 26 00	Contract Modification Procedures
01 29 00	Payment Procedures
01 31 00	Project Management and Coordination
01 32 00	Construction Progress Documentation
01 32 33	Photographic Documentation
01 33 00	Submittal Procedures
01 35 44	Special Procedures for Environmental Health and Safety and Fire and Life Safety
01 35 46	Indoor Air Quality Procedures
01 40 00	Quality Requirements
01 41 00	Regulatory Requirements
01 42 00	References
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01 73 00	Execution
01 73 05	Utility Interruption – Mechanical, Electrical, Plumbing
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### DIVISION 09 – FINISHES

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21 10 00	Automatic Fire Sprinkler Systems for Fire Suppression

### DIVISION 23 – HVAC

Section	Title
23 05 00	Common Work Results for Mechanical Systems
23 05 23	General Duty Valves for HVAC Systems

<b>Section</b>	<b>Title</b>
23 05 25	VFDs for HVAC Systems
23 05 29	Hangers and Supports for Mechanical Systems
23 05 93	Testing, Adjusting, and Balancing for HVAC Systems
23 07 00	Mechanical Insulation
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23 09 93	HVAC Sequence of Operation
23 21 13	Hydronic Piping
23 21 16	Hydronic Piping Specialties
23 21 23	Hydronic Pumps
23 25 00	Water Treatment
23 82 00	Convection Units

**DIVISION 26 – Electrical**

See Electrical Drawings

## **SECTION 01 00 00 - GENERAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

##### **A. Design Requirements:**

1. Content: Include, as applicable, the following Sections:
  - a. SECTION 01 00 00 – SUMMARY.
  - b. SECTION 01 25 00 – SUBSTITUTION PROCEDURES.
  - c. SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES.
  - d. SECTION 01 31 00 – PROJECT MANagements AND COORDINATION.
  - e. SECTION 01 32 33 – PHOTOGRAPHIC DOCUMENTATION.
  - f. SECTION 01 33 00 – SUBMITTAL PROCEDURES.
  - g. SECTION 01 35 00 – SPECIAL PROCEDURES.
    - 1) This Section includes special environment health and safety procedures unique to work at University projects.
  - h. SECTION 01 35 46 – INDOOR AIR QUALITY PROCEDURES
    - 1) This Section includes special procedures required by the University to maintain a high level of indoor air quality both during construction and subsequent to occupancy.
  - i. SECTION 01 40 00 – QUALITY REQUIREMENTS.
  - j. SECTION 01 41 00 – REGULATORY REQUIREMENTS.
  - k. SECTION 01 42 00 – REFERENCES.
  - l. SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS.
  - m. SECTION 01 60 00 – PRODUCT REQUIREMENTS.
  - n. SECTION 01 73 00 – CLOSEOUT PROCEDURES.
  - o. SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.
  - p. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA.
  - q. SECTION 01 78 39 – PROJECT RECORD DOCUMENTS.
  - r. SECTION 01 78 46 – EXTRA STOCK MATERIALS.
  - s. SECTION 01 79 00 – DEMONSTRATION AND TRAINING.
  - t. SECTION 01 81 13 – SUSTAINABLE DESIGN REQUIREMENTS.
  - u. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

**END OF SECTION 01 00 00**



## SECTION 01 25 00

### SUBSTITUTION 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. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Section 01 21 00 "Allowances" for products selected under an allowance, if applicable.
  - 2. Section 01 23 00 "Alternates" for products selected under an alternate, if applicable.
  - 3. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

##### 1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor or University that are not required in order to meet other Project requirements but may offer advantage to Contractor or University.

##### 1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit each request for consideration in format and quantities specified in Section 01 33 00 "Submittal Procedures". Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use CSI Form 13.1A or Contractor-generated form with substantially the same information.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.

- b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by University and separate contractors that will be necessary to accommodate proposed substitution.
  - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
  - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect/Engineer's Action: If necessary, Architect/Engineer in consultation with the University will request additional information or documentation for evaluation within seven calendar days of receipt of a request for substitution. Architect/Engineer in consultation with the University will notify Contractor of acceptance or rejection of proposed substitution within 14 calendar days of receipt of request, or seven calendar days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order.
  - b. Use product specified if Architect/Engineer does not issue a decision on use of a proposed substitution within time allocated.

## 1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

## 1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

## PART 2 - PRODUCTS

### 2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 14 calendar days prior to time required for preparation and review of related submittals.
1. Conditions: Architect/Engineer in consultation with the University will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer will return requests without action, except to record noncompliance with these requirements:
- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
  - b. Requested substitution provides sustainable design characteristics that specified product provided.
  - c. Substitution request is fully documented and properly submitted.
  - d. Requested substitution will not adversely affect Contractor's construction schedule.
  - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - f. Requested substitution is compatible with other portions of the Work.
  - g. Requested substitution has been coordinated with other portions of the Work.
  - h. Requested substitution provides specified warranty.
  - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed.

## PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 25 00**





## SECTION 01 26 00

### CONTRACT MODIFICATION 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. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
  - 2. Contractor's Agreement Design/Bid/Build, State Form SC-6.21 and The General Conditions of the Construction Contract Design/Bid/Build, State Form SC-6.23 for definitions and contractual requirements related to contract modification procedures.

##### 1.3 DEFINITIONS

- A. Change Order: A written order in compliance with the requirements of the Contract authorizing changes in the Work. For the purposes of this Section a Change Order and a Contract Amendment shall have the same meaning.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Contractor's Authorized Signatory: Submit name of individual authorized to accept changes and responsible for informing others employed by Contractor of changes in the Work.

##### 1.5 MINOR CHANGES IN THE WORK

- A. Architect/Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

##### 1.6 CHANGE ORDER BULLETIN

- A. University-Initiated Change Order Bulletin: Architect/Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications. It will also state the time period for which the request will remain valid.

1. Change Order Bulletin Form: State Form SC-6.311 available on the website of the Office of the State Architect.
2. Work Change Order Bulletins issued by Architect/Engineer are not instructions either to stop work in progress or to execute the proposed change.

B. Contractor-Initiated Change Order Bulletin: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect/Engineer.

1. Change Order Bulletin Form: State Form SC-6.311 available from the website of the Office of the State Architect.
2. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

## 1.7 CHANGE ORDER PROPOSAL

A. Change Order Proposal: In response to a University-Initiated Change Order Bulletin or accompanying a Contractor-Initiated Change Order Bulletin, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change described.

1. Change Order Proposal Form: State Form SC-6.312 available from the website of the Office of the State Architect.
2. Labor Rates: Prior to submitting first Change Order Proposal, submit bare, unburdened hourly labor rates for all contractor and subcontractor labor categories; submit itemized breakdown of all applicable additional labor benefit costs to be added to the bare labor cost to arrive at the total burdened hourly labor cost.
3. Equipment Costs: Provide cost backup for all equipment clearly indicating equipment billing rates and sufficient to demonstrate, as determined by the University Project Manager, that proposed rates are competitive and reasonable in all cases. Submit completed Change Order Proposal Form within the requested timeframe. Include backup documentation to support calculations consistent with Contract provisions, including but not limited to, the following:
  - a. Contractor and Subcontractor labor, material and equipment costs including:
    - 1) A list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - 2) Applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - 3) Costs of labor and supervision directly attributable to the change and as permitted by the terms and conditions of the General Contract for Construction.
  - b. Contractor and Subcontractor overhead and profit.
  - c. Contractor's bond cost.
  - d. Justification for Change in Contract Time: An updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
4. Maintain detailed records of work completed. Provide complete information for evaluation of proposed changes and to substantiate proposed changes in Contract Sum or Contract Time.

1.8 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 01 21 00 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 01 22 00 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.9 CHANGE ORDER PROCEDURES

- A. Submit three signed copies of Change Order Proposal to Architect/Engineer for review.
  - 1. University-Initiated Change Order Bulletins: University and Architect/Engineer will evaluate Contractor's Change Order Proposal and either request additional information or suggest modifications. Based on this review and evaluation University will either accept or reject the proposal.
  - 2. Contractor-Initiated Change Order Bulletins: Architect/Engineer will evaluate Contractor's claim based on the terms and conditions of the Contractor Agreement and General Conditions of the Construction Contract, as applicable.
  - 3. Architect/Engineer's Action: When satisfied as to the accuracy and completeness of the Change Order Proposal, the Architect/Engineer will sign all three copies and forward to the University for consideration.
- B. On University's approval of a Change Order Proposal, Architect/Engineer will prepare, sign and forward three copies of a Change Order, State Form SC-6.31 available from the website of the Office of the State Architect, for signature by the Contractor. Contractor then forwards all three copies of signed Change Order to the University for signature and distribution of fully executed copies to Architect/Engineer and Contractor for record.
- C. Upon receipt of a fully executed Change Order, promptly perform the following:
  - 1. Revise Schedule of Values on the Application for Payment Form by indicating each authorized Change Order as a separate line item and adjusting the Contract Sum as shown on the Change Order.
    - a. University will not pay for changes to the Work until authorized by a Change Order signed by all parties.
  - 2. Revise the Progress Schedule to reflect any change in the Contract Time.
  - 3. Enter changes in the Project Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 26 00**



## SECTION 01 29 00

### PAYMENT 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. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
  - 1. Section 01 21 00 "Allowances" for procedural requirements governing the handling and processing of allowances.
  - 2. Section 01 22 00 "Unit Prices" for administrative requirements governing the use of unit prices.
  - 3. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
  - 4. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
  - 5. For projects required to obtain LEED certification, Division 01 Section "Sustainable Design Requirements" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.

##### 1.3 DEFINITIONS

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

##### 1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule. Schedule of values report from cost-loaded Critical Path Method Schedule prepared in accordance with Section 01 32 00 "Construction Progress Documentation" may serve to satisfy requirements for the schedule of values.
  - 1. Coordinate 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.
      - 1) Construction Manager's Fee.

- 2) Estimated Project General Conditions Costs.
2. Submit schedule of values and hold a conference with the Architect/Engineer and University Project Manager to finalize the schedule of values at earliest possible date, but no later than 10 business days before the date scheduled for submittal of initial Certificates and Applications for Payment.
- B. Format and Content: Use 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 Architect/Engineer.
    - c. Architect/Engineer's project number.
    - d. Contractor's name and address.
    - e. Date of submittal.
  2. 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.
  3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
    - a. Include separate line items under Contractor and principal subcontracts for LEED documentation, where applicable, and other Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
  4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
  5. 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.
  6. 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 a direct cost of actual work-in-place shall be shown as separate line items in the schedule of values.

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

#### 1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect/Engineer and paid for by University.
  1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Pay Application and Schedule Review Meetings: Conduct in accordance with Section 01 31 00 "Project Management and Coordination." Provide draft application for payment and draft schedule update reflecting work accomplished during previous pay period. Review progress achieved; discuss and resolve issues affecting the progress; and review critical activities to be accomplished during the following 90 calendar days.
  1. Jobsite Walk: When required, conduct a walk of the jobsite to confirm progress related to any activity in question.
- C. Monthly Schedule Reporting: Upon conclusion of the Pay Application and Schedule Review Meeting, but not later than the 28th of the month, update the Construction Schedule and submit the Pay Application.
- D. Payment Application Times: Submit Application for Payment to Architect/Engineer by the first day of the month and no more than five (5) business days prior thereto. The period covered by each Application for Payment is per the date indicated in the Application.
- E. Payment Application Review: The Architect/Engineer shall, within five (5) business days after the receipt of each Certificate and Application for Payment, review the Project Application for Payment and either execute a Project Certificate for Payment to the University or notify the Contractor in writing of the reasons for withholding a Certificate.
  1. All applications for payment, except the final application, and the payments there under, shall be subject to correction in the next application rendered following the discovery of any error
- F. Application for Payment Forms: Use State Form SBP-7.2 "Certification for Contractor Payment."
- G. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect/Engineer 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 issued before last day of construction period covered by application.
  4. Indicate separate amounts for work being carried out under University-requested project acceleration.
- H. 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 as



approved in advance by the University Project Manager and items stored at an off-site location previously agreed upon in writing.

1. Provide certificate of insurance, evidence of transfer of title to University, 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. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- I. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect/Engineer by a method ensuring receipt. 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.
- J. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
  2. Schedule of values.
  3. For projects required to obtain LEED certification, LEED submittal for project materials cost data.
  4. Contractor's construction schedule (preliminary if not final).
  5. Products list (preliminary if not final).
  6. For projects required to obtain LEED certification, LEED action plans.
  7. Schedule of unit prices.
  8. Submittal schedule (preliminary if not final).
  9. List of Contractor's staff assignments.
  10. List of Contractor's principal consultants.
  11. Copies of building permits.
  12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  13. Initial progress report.
  14. Report of preconstruction conference.
- K. Application for Payment at Substantial Completion: After Architect/Engineer issues 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 Certificate(s) of Substantial Completion issued previously for University occupancy of designated portions of the Work.
- L. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. All items on Pre-acceptance Checklist (State Form SBP-05) have been completed.
2. Notice of Acceptance (State Form SBP-6.27) has been issued.
3. Statements to support local sales tax refunds, if any submitted.
4. Notice of Contractor's settlement has been published.
5. Evidence of completion of Project closeout requirements, including but not limited to:
  - a. Submittal of Record Documents.
  - b. Submittal of all Operation and Maintenance Manuals.
  - c. Completion of all required demonstration and training.
6. Updated final statement, accounting for final changes to the Contract Sum.
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 University 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 01 29 00**



## SECTION 01 31 00

### 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. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. Coordination drawings.
  - 3. Requests for Information (RFIs).
  - 4. Project Web site.
  - 5. Project meetings.
- B. Related Requirements:
  - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
  - 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
  - 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

##### 1.3 DEFINITIONS

- A. RFI: Request from Contractor seeking information required by or clarifications of the Contract Documents.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Within 21 calendar days of Notice of Award submit, as complete as possible, a preliminary list to include all major subcontractors. Augment, complete and submit the final subcontractor list within 60 calendar days of Notice of Award, unless a longer duration is approved by the Architect/Engineer. Include the following information in tabular form:
  - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

- B. Key Personnel Names: Within 14 calendar days after Notice to Proceed, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

## 1.5 GENERAL COORDINATION PROCEDURES

- A. General: Each entity involved in the performance of work for the entire Project shall cooperate in the overall coordination of the Work; promptly, when requested, furnish information concerning its portion of the Work; and respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervision, administrative or similar authority.

### 1. University Standard Project Management Forms

- a. Where applicable, obtain from the University Project Manager and use the following University Standard Forms:

- 1) Preconstruction Agenda
- 2) Change Order Log with Contingency Codes
- 3) Access Control Badge Application Form
- 4) Utility Interruption Request Form
- 5) Utility Start-Up Request Form
- 6) Fire Alarm/Sprinkler Disable Request Form
- 7) Hot Work Permit Form
- 8) Anschutz Medical Campus (AMC) Street and Parking Lot Closure Form
- 9) Indoor Air Quality (IAQ) Planning Checklist
- 10) Indoor Air Quality (IAQ) Inspection Checklist

### 2. Site Utilization:

- a. In addition to the site utilization limitations and requirements indicated in Section 01 10 00 "Summary" and indicated by the Contract Documents; administer the allocation of available space equitably among entities needing access and space, so as to produce the best overall efficiency in the performance of the total work of the project. Schedule deliveries so as to minimize the space and time requirements for storage of materials and equipment on the site; but do not unduly risk delays in the work.
- b. Concurrent with work of the Contractor, other contractors, suppliers, and the University personnel may be working in relatively close proximity. The Contractor is solely responsible for coordinating their work with that of other contractors and will make no claims for failure to do so.

### 3. Layout:

- a. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishment and coordination of these relationships is the exclusive responsibility of the Contractor. Do not scale the drawings. Lay out and arrange all elements to contribute to safety, efficiency and to carry the harmony of design throughout the Work. In case of conflict or undimensioned locations, verify required positioning with Architect/Engineer.

### 4. Substrate Examination:

- a. The Installer of each element of the work must examine the conditions of the substrate to receive the work, dimensions and spaces adjacent, tolerances, interfacing with other elements and services, and the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper or timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
5. Large and Heavy Equipment:
- a. Contractor to coordinate with University Project Manager requirements to be maintained for the subsequent entry of large equipment units. Coordinate the movement of heavy items with shoring and bracing, so that the building structure will not be overloaded during the movement and installation.
  - b. Where equipment or products to be installed on the roof are too heavy to be hand-carried, do not transport across roof deck; position by crane or other device so as to avoid overloading the roof deck.
- B. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections of the Specification that depend on each other for proper installation, connection, and operation.
1. Contractor Communication with the University: Direct all communication with the University through the University Project Manager.
  2. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  3. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  4. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for University and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
  2. Preparation of the schedule of values.
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Preinstallation conferences.
  7. Project closeout activities.
  8. Startup and adjustment of systems.
- E. Coordination Of Submittals: Prior to transmittal to the Architect/Engineer, review shop and erection drawings, product data, and samples for compliance with Contract Documents and for coordination among work of all Sections of the Specifications. Coordination of submittals shall include, but not be limited to the following:

1. Verification of field dimensions and clearances and relationship to available space and anchors.
2. Verification of compatibility with equipment and work of other Sections, electrical characteristics, and operational control requirements.
3. Verification of motor voltages and control characteristics.
4. Coordination of controls, interlocks, wiring of pneumatic switches, and relays.
5. Coordination of wiring and control diagrams.
6. Review of the effect of any changes on work of other Sections.
7. For any item to be installed in or on a finished surface, certify that applicable Contract Documents have been checked and that the item submitted is compatible with the surface finish on which it is to be installed.
8. Equipment and material submittals shall show sufficient data to indicate complete compliance with Contract Documents as follows:
  - a. Proper sizes and capabilities.
  - b. Ability to fit in the available space in a manner that will allow proper service.
  - c. Construction methods, materials, and finishes.
  - d. List of accessories.

F. Special Coordination Requirements for Mechanical and Electrical Work:

1. General: Provide necessary work and services required to coordinate the complete installation of heating, ventilating, and air conditioning (HVAC) equipment and systems; plumbing systems and fixtures; electrical equipment, fixtures, and systems; and other equipment or systems containing motors and controls or requiring connection to mechanical or electrical systems; all so that the various systems perform as indicated and are in harmony with other project Work.
2. Contract Drawings:
  - a. Drawings are schematic in nature, and indicate in general how the various components are integrated with other parts of the building. Coordinate exact locations by job measurement, by verifying the requirements of other trades, and by review of Contract Documents.
3. Mechanical and Electrical Drawings indicate general routing of the various parts of the systems, but do not indicate all sizes, fittings, offsets, and runouts which are required. Coordinate correct sizes, fittings, offsets, and runouts required to fit systems into allocated spaces. Coordinate locations of all light fixtures, vents, and supply grilles to conform to the ceiling grid system or other modular finishes.
4. Coordinate installation of mechanical and electrical work in compliance with the following requirements:
  - a. Install piping, ductwork and similar services straight and true, aligned with other work, close to walls and overhead structure, allowing for insulation, concealed (except where indicated as exposed) in occupied spaces, and out-of-the-way with maximum passageway and headroom remaining in each space.
  - b. Install electrical work in a neat, organized manner with conduit and similar services in or parallel with building lines, and concealed unless indicated as exposed.
  - c. For all work maintain maximum practical overhead clearance but not less than 6" above ceiling. Where exposed, maintain 7'-0" minimum clearance.
  - d. Arrange all work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.
  - e. Provide space to permit removal of coils, tubes, fan shafts, filters, other parts which may require replacement.
  - f. Locate operating and control equipment and devices for easy access. Furnish access panels where units are concealed by finishes and similar work.

- g. Integrate mechanical work in ceiling plenums with suspension system, light fixtures and other work, so that required performances of each will be achieved.
  - h. Give the right-of-way to piping systems required to slope for drainage over other service lines and ductwork.
  - i. Advise other trades of openings required in their work for accommodation of mechanical and electrical elements. Provide and place sleeves and anchors required in other work.
5. Access to Equipment: Except where located above accessible ceilings, provide access panels wherever access is required to concealed valves, controls, dampers, pull boxes and other devices requiring ongoing or periodic access.
- a. Acceptable types of access panels are specified in Division 08.
  - b. Each trade is responsible for providing access panels needed for access to their equipment and coordinating installation with other Division 03, 04, 06 and 09 trades.
  - c. Coordinate requirements and obtain approval of locations from Architect/Engineer.

G. Compatibility of Systems:

- 1. Provide products and equipment which are compatible with other work requiring mechanical/electrical interface including electrical connections, control devices, water, drain and other piping connections. Verify electrical characteristics, fuel requirements and other interface requirements before ordering equipment and resolve conflicts that may arise.
- 2. Coordinate equipment, mechanical and electrical work in accordance with the following schedule:

<u>ITEM</u>	<u>FURNISHED BY</u>	<u>MOUNTED BY</u>	<u>LOW VOLTAGE WIRED BY</u>	<u>POWER WIRED &amp; CONNECTED BY</u>	<u>LOW VOLTAGE CONTROL CONNECTED BY</u>
Equipment motors	I	MI	MI	EI	--
Motor starters, contactors and overload heaters	MI	EI	EI	EI	MI
Fused and unfused disconnect switches	EI**	EI**	EI**	EI	--
Manual operating switches, speed switches, push-button stations and pilot lights	MI	EI	EI	EI	EI
Duct detectors	EI	MI	MI	EI	MI
Control relays and transformers	MI	MI	MI	EI	MI
Thermostats, time switches*	MI	MI	MI	EI	MI
Temperature control panels	MI	MI	MI	EI	MI
Motor and solenoid valves, damper motors, PE and EP switches	MI	MI	MI	--	MI
Refrigeration equipment, cooling tower and controls	MI	MI	MI	EI	MI



Electric meters	EI	EI	EI	EI	MI
Steam meters	MI	MI	MI	MI	MI
Chilled water meters,	MI	MI	MI	MI	MI
Water meters	MI***	MI	MI	MI	MI
Natural Gas	MI	MI	MI	MI	MI
<p>I = Installer of equipment requiring electrical service                      EI = Electrical Installer                      MI = Mechanical Installer</p> <p>* Motor driven units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract. However, if the control device does not conduct full load current, then the responsibility shall be that set forth in the above schedule. (Example: a 208 volt, 3-phase, 3- wire motor requires 120 volt control. Electrical Installer shall furnish a 120 volt circuit for control and 208 volt circuit for power and wire the power circuit. Mechanical Installer shall wire the control circuit.)</p> <p>** Disconnects for AH units are factory mounted.</p> <p>***Building Service meter provided by Civil. Any sub meter provided by MI. Coordinate meter requirements with utility for remote monitoring by 23 09 00 – Instrumentation and Controls.</p>					

H. Special Coordination Requirements for Exterior Envelope Work:

1. General: Provide necessary work and services required to coordinate the complete and continuous installation of the building’s heat, air and moisture barriers. Exterior building envelope construction to be coordinated includes, but is not limited to, below-grade walls, slabs-on-grade, exterior opaque walls, windows, curtain walls, roofs, and skylights.
2. Contract Drawings:
  - a. Drawings indicate general concepts and design intent for continuity of heat, air and moisture barriers at each exterior building envelope component and at transitions between building envelope components. Coordinate details for continuity based on actual product selections and Contractor’s proposed sequence of construction.

I. Complete Systems:

1. It is the intent of the Contract Documents that all systems, including mechanical and electrical, be complete and functional to provide the intended or specified performance. Provide all incidental items and parts necessary to achieve this requirement.
2. Provide correctly sized power, utilities, piping, drains, services and their connections to equipment and systems requiring them, whether or not specific items are listed in the schedule under “Compatibility of Systems” paragraph in this Section.

J. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as University's property.

2. Establish recycling program at job site. Refer to Section 01 74 19 “Construction Waste Management and Disposal” for additional requirements.

## 1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
  - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
  - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple subcontractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
  - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
  - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
  - f. Indicate required installation sequences.
  - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect/Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings, where required, to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
  - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
  - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.

- c. Fire-rated enclosures around ductwork.
  7. Electrical Work: Show the following:
    - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
    - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
  8. Fire-Protection System: Show the following:
    - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
  9. Windows, Curtain Wall, and Exterior Wall Assembly Transition Work: Show all components of each adjacent wall or window system and all required compatible tie-ins between them including transition strips, flashings and sealants. Clearly identify each product, its configuration and its extent. Shop Drawings which only generically indicate adjacent construction and/or indicate "construction by others" will not be acceptable.
  10. Review: Architect/Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect/Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect/Engineer will so inform Contractor, who shall make changes as directed and resubmit.
  11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."
- C. Virtual Design and Construction (VDC), Building Information Model (BIM) and Coordination Digital Data Files:
1. General: It is expected that, to the greatest extent applicable, Contractor will employ VDC and BIM tools to facilitate the construction, coordination, scheduling and phasing of the Work.
  2. Contractor's VDC implementation shall include at a minimum the following activities:
    - a. Development and maintenance of a three-dimensional building information model (BIM) of the Work that includes contractor-developed, shop-drawing level information of the following building components and systems:
      - 1) Building structure, including but not limited to, foundations, columns, beams, joists, purlins, floor and roof decking and fill, bracing, and load-bearing walls.
      - 2) HVAC systems, including but not limited to, HVAC piping and pumps, air distribution ductwork, fans, air terminal units, air outlets and inlets; central cooling equipment compressors, chillers, condensers, and cooling towers; boilers, heat exchangers and packaged and/or custom air-handling units and thermal storage systems.
      - 3) Plumbing systems, including but not limited to, water distribution, storm drainage and sanitary sewerage waste and vent piping, water-heaters and plumbing fixtures.
      - 4) Fire suppression systems, including but not limited to, standpipes, sprinkler systems, fire pumps, and non-water-based fire-extinguishing systems.
      - 5) Electrical systems, including but not limited to, conduit greater than 1-1/2 inches in diameter, or bundled conduits, cable-tray, transformers, switchgear, switchboards, panelboards, generators, lightning protection and lighting.
      - 6) Communication systems, including but not limited to, structured cabling, premise wiring distribution system, equipment room fittings, racks, frames and enclosures,

- data communications switches, hubs, and routers, common use systems, and paging systems
      - 7) Vertical Transportation systems including.
      - 8) Architectural building systems including interior and exterior walls, windows, curtain walls, ceilings, and roof.
    - b. Collision Detection Reports: Based on information developed and included in the Contractor's three-dimensional BIM, perform collision/interference checking and develop reports for review and resolution by the integrated Contractor team, including subcontractors, manufacturers and suppliers, working with the Design team where needed prior to release of fabrication drawings.
  - 3. Schedule Visualization: Develop and maintain a three-dimension building information model for the expressed purpose of visually demonstrating and communicating proposed project construction schedule and phasing to University, subcontractors and suppliers as applicable. Include all major building systems and construct in such a fashion as to permit animation showing sequential construction of the project based on and driven by the approved Primavera construction schedule.
  - 4. Prepare coordination digital data files according to the following requirements:
    - a. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
    - b. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format and Portable Data File (PDF) format.
    - c. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
      - 1) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect/Engineer.
    - d. Architect/Engineer will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
      - 1) Architect/Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
      - 2) Digital Data Software Program: Drawings are available in <Insert name and version of digital data software program and operating system>.
      - 3) Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to University and Architect/Engineer.
  - 5. Review: At request of Contractor and at Architect/Engineer's discretion, Architect/Engineer will participate in BIM coordination and review meetings and will review coordination model and drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Architect/Engineer determines that the coordination model and drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Architect/Engineer will inform the Contractor, who shall make changes as directed and resubmit.

D. Interference Resolution: Whenever job measurements and an analysis of the building coordination model, Drawings and Specifications indicate that the various systems cannot be installed without significant deviation from the intent of the Contract, prepare interference drawings as required to indicate conflict between the various systems and other components of the building such as beams, columns, and walls. Include plans, elevations, sections, and other details drawn to large scale as required to clearly

define the interference and to indicate the Contractor's proposed solution. Submit interference drawings for review by the Architect prior to proceeding with work in the general areas of the conflict.

#### 1.7 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect/Engineer will return RFIs submitted to Architect/Engineer by other entities controlled by Contractor with no response.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Architect/Engineer.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
  14. Space for response and signature by Architect/Engineer.
- C. RFI Forms: Hard copy form or software-generated form with substantially the same content as indicated above, acceptable to Architect/Engineer.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect/Engineer's Action: Architect/Engineer will review each RFI, determine action required, and respond. Allow seven calendar days for Architect/Engineer's response for each RFI. RFIs received by Architect/Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.

- f. Requests for interpretation of Architect/Engineer's actions on submittals.
      - g. Incomplete RFIs or inaccurately prepared RFIs.
    2. Architect/Engineer's action may include a request for additional information, in which case Architect/Engineer's time for response will date from time of receipt of additional information.
    3. Architect/Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Contractor-Initiated Change Order Bulletin and Proposal according to Section 01 26 00 "Contract Modification Procedures."
      - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect/Engineer in writing within seven calendar days of receipt of the RFI response.
  - E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by RFI number. Submit log weekly. Use CSI Log Form 13.2B or Contractor-generated form of substantially same content. Include the following:
    1. Project name.
    2. Name and address of Contractor.
    3. Name and address of Architect/Engineer.
    4. RFI number including RFIs that were returned without action or withdrawn.
    5. RFI description.
    6. Date the RFI was submitted.
    7. Date Architect/Engineer's response was received.
  - F. On receipt of Architect/Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect/Engineer within seven calendar days if Contractor disagrees with response.
- 1.8 PROJECT MEETINGS
  - A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
    1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify University and Architect/Engineer of scheduled meeting dates and times a minimum of 4 business days prior to meeting.
      - a. Participants, including representatives of subcontractors and suppliers, shall be qualified, familiar with Project and authorized to conclude matters relating to the Work.
    2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
    3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including University and Architect/Engineer, within three business days of the meeting.
  - B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time and site convenient to all parties, but not later than 14 calendar days after Notice to Proceed.
    1. Conduct the conference to review responsibilities and personnel assignments.
    2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:
      - a. Authorized representatives of University:

- 1) University Project Manager.
  - 2) University Building Maintenance Operations (BMO) Representative.
  - b. Architect/Engineer and their consultants.
  - c. Contractor's project manager and superintendent.
  - d. Major subcontractors and suppliers.
  - e. Other concerned parties shall attend the conference.
3. Agenda: Discuss items of significance that could affect progress, including the following:
- a. Designation of key personnel and their duties.
  - b. Lines of communications.
  - c. List of major subcontractors and suppliers.
  - d. Tentative construction schedule.
    - 1) Phasing.
    - 2) Critical work sequencing and long-lead items.
    - 3) Equipment deliveries and priorities.
  - e. Procedures and processing of:
    - 1) Change Order Bulletin, Change Order Proposal and Change Orders.
    - 2) RFI's
    - 3) Testing and inspecting.
    - 4) Applications for Payment.
    - 5) Submittals.
    - 6) Preparation of record documents.
  - f. Use of the premises, existing building and adjacent buildings as applicable.
    - 1) Work restrictions.
    - 2) Working hours.
    - 3) University's occupancy requirements.
    - 4) Procedures for disruptions and shutdowns.
    - 5) Construction parking and staging.
    - 6) Construction route and site access.
    - 7) Office, work, and storage areas.
    - 8) Progress cleaning and housekeeping procedures.
  - g. Project coordination.
  - h. Distribution of the Contract Documents.
  - i. Temporary facilities and controls.
  - j. Indoor Air Quality Plan and Monitoring including procedures for moisture and mold control.
  - k. Construction waste management and recycling.
  - l. Safety.
    - 1) Fire and Life Safety.
    - 2) Health and Safety.
  - m. First aid.
  - n. Security.
  - o. Building Department.
  - p. Telecommunications.
  - q. Building Services.

- r. Building Operations.
  - s. University Work Related Policies.
  - t. Contractor Contacts.
  - u. University Contacts.
  - v. University Process Forms.
    - 1) Key Request Form.
    - 2) Access Control Badge Application Form.
    - 3) Utility Interruption Request Form.
    - 4) Utility Start-Up Form.
    - 5) Fire Alarm/ Sprinkler Disable Request Form.
    - 6) Hot Work Permit Form.
    - 7) Anschutz Medical Campus (AMC) Street and Parking Lot Closure Form.
    - 8) Indoor Air Quality (IAQ) Plan.
    - 9) IAQ Planning Checklist.
    - 10) IAQ Inspection Checklist.
    - 11) Request for Variance.
4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site for installations, systems or assemblies where required by individual Specification Sections, or where deemed necessary by Contractor.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect/Engineer of scheduled meeting dates.
  - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following, as appropriate:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. LEED requirements, for projects pursuing LEED certification.
    - i. Review of mockups.
    - j. Possible conflicts.
    - k. Compatibility requirements.
    - l. Time schedules.
    - m. Weather limitations.
    - n. Manufacturer's written instructions.
    - o. Warranty requirements.
    - p. Compatibility of materials.
    - q. Acceptability of substrates.
    - r. Temporary facilities and controls.
    - s. Space and access limitations.
    - t. Regulations of authorities having jurisdiction.
    - u. Testing and inspecting requirements.
    - v. Installation procedures.
    - w. Coordination with other work.
    - x. Required performance results.
    - y. Protection of adjacent work.



- z. Protection of construction and personnel.
  - 3. Record significant conference discussions, approved schedules, agreements, and disagreements, including required corrective measures and actions.
  - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information, including University Project Manager and Architect/Engineer.
  - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to University and Architect/Engineer, but no later than 90 calendar days prior to the scheduled date of Substantial Completion or Partial Substantial Completion.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
  - 2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:
    - a. University Project Manager.
    - b. University Building Maintenance Operations (BMO) Representative.
    - c. Architect/Engineer and their consultants.
    - d. Contractor's project manager and superintendent.
    - e. Major subcontractors and suppliers.
    - f. Other concerned parties.
  - 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
    - a. Procedures related to:
      - 1) Notice of Completion, including preparation of Contractor's punch list.
      - 2) Final Inspection.
      - 3) Notice of Substantial Completion.
      - 4) Notice of Approval of Occupancy/Use.
      - 5) Supplemental Occupancy/Use Checklist.
      - 6) Supplemental Acceptance Checklist.
      - 7) Pre-acceptance Checklists.
      - 8) Notice of Acceptance.
      - 9) Settlement and Final Payment.
    - b. Preparation of record documents.
    - c. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    - d. Submittal of written warranties.
    - e. Requirements for completing LEED documentation, for projects pursuing LEED certification.
    - f. Requirements for preparing operations and maintenance data.
    - g. Requirements for delivery of material samples, attic stock, and spare parts.
    - h. Requirements for demonstration and training.
    - i. University's partial occupancy requirements.
    - j. Installation of University's furniture, fixtures, and equipment.
    - k. Responsibility for removing temporary facilities and controls.
  - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

- E. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
  2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:
    - a. University Project Manager.
    - b. University Health Safety Department Representative.
    - c. University Building Maintenance Operations Representative.
    - d. University Campus Building Official.
    - e. Architect/Engineer and their consultants.
    - f. Contractor's project manager and superintendent.
    - g. Major subcontractors and suppliers.
    - h. Other entities concerned with current progress or involved in planning, coordination, or performance of future activities.
    - i. As needed, University Building Maintenance Operations (BMO), Subject Matter Experts (SME), and University Facility Support Services (FSS) Representatives.
  3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule:
      - 1) Review progress since the last meeting.
      - 2) Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule.
      - 3) Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 4) Review schedule for next two week period.
      - 5) Review schedule of deliveries.
      - 6) Review off-site fabrication.
    - b. Site Safety.
    - c. Indoor Air Quality Management monitoring.
    - d. MS4 Storm Water and Water Quality monitoring.
    - e. Quality:
      - 1) Quality and work standards.
      - 2) Status of correction of deficient items.
      - 3) Progress cleaning.
      - 4) Field observations.
    - f. Status of submittals.
    - g. Status of RFIs.
    - h. Status of Changes including:
      - 1) Change Order Bulletins.
      - 2) Change Order Proposals.
      - 3) Change Orders.
      - 4) Pending claims and disputes.
    - i. Status of LEED documentation, for projects pursuing LEED certification.

- j. Review present and future needs of each entity present including:
  - 1) Access.
  - 2) Site utilization.
  - 3) Temporary facilities and controls.
  - 4) Coordination.
- 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
- F. Pay Application and Schedule Review Meeting: Conduct review meeting monthly on or about the 25<sup>th</sup> of each month.
  - 1. Attendees:
    - a. University Project Manager.
    - b. Architect/Engineer.
    - c. Contractor's Project Manager, Superintendant and Scheduler.
  - 2. Agenda: Review draft pay application and progress schedule update in accordance with the requirements of Section 01 29 00 "Payment Procedures" and Section 01 32 00 "Construction Progress Documentation."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 31 00**

## SECTION 01 32 00

### 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. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Monthly project status reports.
6. Material location reports.
7. Site condition reports.
8. Special reports.

- B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

##### 1.3 DEFINITIONS

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

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum exclusive of profit, overhead, and general conditions costs.

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

- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time is not for the exclusive use or benefit of either University or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
  - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
  - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower necessary for the completion of an activity as scheduled.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. Working electronic copy of schedule file, where indicated.
  - 2. PDF electronic file and four paper copies.
- B. Startup construction schedule (bar chart).
  - 1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Preliminary Schedule and Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Detailed Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
  - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. Construction Schedule Updating Reports: Submit draft for discussion at monthly project schedule and pay application review meeting. Submit final report with monthly Application for Payment.
- F. Daily Construction Reports: Submit at weekly intervals.
- G. Material Location Reports: Submit at monthly intervals.
- H. Site Condition Reports: Submit at time of discovery of differing conditions.
- I. Special Reports: Submit at time of unusual event.
- J. Qualification Data: For scheduling consultant or in-house scheduling expert.

## 1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with a minimum of 5 years experience and capability of producing CPM reports and diagrams within 24 hours of Architect/Engineer's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
  - 1. Review software limitations and content and format for reports.
  - 2. Verify availability of qualified personnel needed to develop and update schedule.
  - 3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial University occupancy, as may be applicable.
  - 4. Review delivery dates for University-furnished products.
  - 5. Review schedule for work of University's separate contracts.
  - 6. Review submittal requirements and procedures.
  - 7. Review time required for review of submittals and resubmittals.
  - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
  - 9. Review time required for Project closeout and University startup procedures, including commissioning activities.
  - 10. Review and finalize list of construction activities to be included in schedule.
  - 11. Review procedures for updating schedule.

## 1.6 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
  - 1. Secure time commitments for performing critical elements of the Work from entities involved.
  - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

## PART 2 - PRODUCTS

### 2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
  - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date is not permitted. Contract completion date may only be modified by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  - 1. Activity Duration: Define activities so no activity is longer than 21 calendar days, unless specifically allowed by Architect/Engineer.
  - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 calendar days, as separate activities in schedule.

Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
  4. Startup and Testing Time: Include adequate time for startup, testing and commissioning.
  5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect/Engineer's administrative procedures necessary for issuing Notice of Substantial Completion.
- C. Constraints: Include the following constraints and work restrictions as indicated in the Contract Documents and as applicable in schedule; show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
  2. Work by University: Include a separate activity for each portion of the Work performed by University.
  3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  4. University-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  5. Work Restrictions: Show the effect of the following items, as applicable, on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.
    - d. Partial occupancy before Substantial Completion.
    - e. Use of premises restrictions.
    - f. Environmental control.
  6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
    - a. Submittals.
    - b. Mockups.
    - c. Fabrication.
    - d. Sample testing.
    - e. Deliveries.
    - f. Installation.
    - g. Tests and inspections.
    - h. Building flush-out.
    - i. Startup and placement into final use and operation.
  7. Construction Areas: As applicable, identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
    - a. Structural completion.
    - b. Temporary enclosure and space conditioning.
    - c. Permanent space enclosure.
    - d. Completion of mechanical installation.
    - e. Completion of electrical installation.
    - f. Substantial Completion.

- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Commencement of Work, Substantial Completion, Notice of Occupancy and Use, and Final Acceptance. As applicable, also include milestones for Partial Substantial Completion and Partial Notice of Occupancy and Use.
- E. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- F. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules and as approved by University and Architect/Engineer.

## 2.2 STARTUP CONSTRUCTION SCHEDULE (BAR CHART)

- A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven calendar days of date established for commencement of the Work.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 calendar days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

## 2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (BAR CHART OR GANTT CHART)

- A. Bar-Chart or Gantt-Chart Schedule: Submit startup, horizontal, bar-chart-type or a comprehensive, fully developed, horizontal, Gantt-chart-type construction schedule within 30 calendar days of date established for commencement of the Work. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Use the same breakdown of construction activities as indicated in the Schedule of Values.
  - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar. With each required construction schedule update, place a contrasting mark in each bar to indicate actual completion.

## 2.4 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
  - 1. List of subcontractors at Project site.
  - 2. List of separate contractors at Project site.
  - 3. Approximate count of personnel at Project site.
  - 4. Equipment at Project site.
  - 5. Material deliveries.
  - 6. High and low temperatures and general weather conditions, including presence of rain or snow.
  - 7. Accidents.
  - 8. Meetings and significant decisions.



9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Services connected and disconnected.
16. Equipment or system tests and startups.
17. Partial completions and occupancies.
18. Substantial Completions authorized.

B. Monthly Project Status Report: Prepare a monthly project status report including the following:

1. Current status of Project:

- a. Schedule.
- b. Cost.
- c. MBE and WBE participation, as applicable.
- d. RFI's.
- e. Submittals.
- f. Manpower.
- g. Safety.

2. Narrative of progress achieved in previous month, activities anticipated for the next month, and issues affecting the rate of progress.
3. Progress photographs in accordance with Section 01 32 33 "Photographic Documentation."

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

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

D. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## 2.5 SPECIAL REPORTS

- A. General: Submit special reports directly to University within one calendar day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise University in advance when these events are known or predictable.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule draft update schedule for discussion and review at monthly project progress schedule and pay application review meeting.
1. Revise schedule immediately after each meeting and issue updated schedule concurrently with submittal of monthly Application for Payment.
  2. Include summary reports 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 final completion percentage for each activity.
  4. Schedule updates may change logic but may not change milestone or critical path without prior approval of University and Architect/Engineer.
- B. Distribution: Distribute copies of approved schedule to Architect/Engineer University, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

**END OF SECTION 01 32 00**



## SECTION 01 32 33

### 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. Section includes administrative and procedural requirements for the following:
  - 1. Preconstruction photographs.
  - 2. Periodic construction photographs.
  - 3. Final completion construction photographs.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting photographic documentation.
  - 2. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For photographer.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. Digital Photographs: Submit image files within three business days of taking photographs.
  - 1. Digital Camera: Minimum sensor resolution of 12 megapixels.
  - 2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
  - 3. Identification: Provide the following information with each image description in file metadata tag:
    - a. Name of Project.
    - b. Name and contact information for photographer.
    - c. Name of Architect/Engineer.
    - d. Name of Contractor.
    - e. Date photograph was taken.
    - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - g. Unique sequential identifier keyed to accompanying key plan.

#### 1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

#### 1.5 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to University for unlimited reproduction of photographic documentation.

### PART 2 - PRODUCTS

#### 2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

### PART 3 - EXECUTION

#### 3.1 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
  - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
  - 1. Date and Time: Include date and time in file name for each image.
  - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect/Engineer.
- D. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect/Engineer.
  - 1. Flag construction limits before taking construction photographs.
  - 2. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- E. Periodic Construction Photographs: Take 20 photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

- F. Architect/Engineer-Directed Construction Photographs: From time to time, Architect/Engineer will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- G. Final Completion Construction Photographs: Take **20** color photographs after date of Substantial Completion for submission as project record documents. Architect/Engineer will inform photographer of desired vantage points.
  - 1. Do not include date stamp.
- H. Additional Photographs: University through Architect/Engineer may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
  - 1. Three business days' notice will be given, where feasible.
  - 2. In emergency situations, take additional photographs within 24 hours of request.
  - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
    - a. Special events planned at Project site.
    - b. Immediate follow-up when on-site events result in construction damage or losses.
    - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    - d. Substantial Completion of a major phase or component of the Work.
    - e. Extra record photographs at time of final acceptance.
    - f. University's request for special publicity photographs.

**END OF SECTION 01 32 33**



## SECTION 01 33 00

### 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. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
  - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
  - 2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
  - 3. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
  - 4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 5. Division 02 through 33 for additional submittal requirements specific to indicated Specification Sections.

##### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals." Submittals not specifically indicated as informational submittals are considered to be action submittals.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect/Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals" and include, but are not limited to:
  - 1. Schedules.
  - 2. Permits.
  - 3. Applications for payment.
  - 4. Performance and payment bonds.
  - 5. Insurance certificates.
  - 6. List of Subcontractors.
  - 7. Schedule of Values.



8. Inspection and test results.
9. Closeout documents.
10. Coordination drawings.
11. Street and Storm Water Quality Management Plan.
12. Indoor Air Quality Management Plan.
13. Anschutz Medical Campus Street Services Request.

- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

#### 1.4 ACTION SUBMITTALS

- A. Submittals: Refer to individual CSI divisions for additional submittal requirements. If CSI division submittal requirements does not fully cover project scope, contractor shall submittal product data, shop drawings, testing data, certifications, and additional information for all permanent materials and components.
- B. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect/Engineer and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
  2. Initial Submittal: Submit concurrently with startup construction schedule and within 30 calendar days of Notice to Proceed or Commencement of Work, but not later than submittal of first application for payment. Include submittals required during the first 90 calendar days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
  3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
  4. Format: Arrange the following information in a tabular format:
    - a. Scheduled date for first submittal.
    - b. Specification Section number and title.
    - c. Submittal category: Action; informational.
    - d. Name of subcontractor.
    - e. Description of the Work covered.
    - f. Scheduled date for resubmittal.
    - g. Scheduled date for Architect/Engineer's final release or approval.
    - h. Scheduled date of fabrication.
    - i. Scheduled dates for purchasing.
    - j. Scheduled dates for installation.

- k. Activity or event numbers.

## 1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect/Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect/Engineer for Contractor's use in preparing submittals.
  1. Architect/Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings **and Project record drawings**.
    - a. Architect/Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    - b. Digital Drawing Software Program: The Contract Drawings are available in PDF or AutoCAD.
    - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to University and Architect/Engineer.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit for review with sufficient time to avoid construction delays.
  1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Architect/Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect/Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
  1. Initial Review: Allow 14 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect/Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 14 calendar days for review of each resubmittal.
  4. Large and/or Complex Submittals: For large and/or complex submittals, as determined by the Architect/Engineer and for submittals that require sequential reviews by Architect/Engineer's consultants, a review period greater than 14 calendar days may be required. Architect/Engineer and Contractor shall identify such submittals upon submission of the submittal schedule and determine a mutually agreed upon review period.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
  1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

2. Name file with submittal number or other unique identifier, including revision identifier.
  - a. File name shall use project identifier and Specification Section number followed by a dash and then a sequential number (e.g., LNHS-061000-01). Resubmittals shall include an alphabetic suffix after another dash (e.g., LNHS-061000-01-A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect/Engineer.
4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to University, containing the following information:
  - a. Project name.
  - b. Date.
  - c. Name and address of Architect/Engineer.
  - d. Name and address of Contractor.
  - e. Name of firm or entity that prepared submittal.
  - f. Names of subcontractor, manufacturer, and supplier.
  - g. Category and type of submittal.
  - h. Submittal purpose and description.
  - i. Specification Section number and title.
  - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
  - k. Drawing number and detail references, as appropriate.
  - l. Location(s) where product is to be installed, as appropriate.
  - m. Related physical samples submitted directly.
  - n. Indication of full or partial submittal.
  - o. Transmittal number.
  - p. Submittal and transmittal distribution record.
  - q. Other necessary identification.
  - r. Contractor's certification that information complies with Contract Document requirements.
  - s. Remarks.
- E. Options: Identify options requiring selection by Architect/Engineer.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect/Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Contractor Certification: On transmittal include Contractor's certification that information complies with Contract Document requirements.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
  1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Architect/Engineer's action stamp.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect/Engineer's action stamp.

- K. Record Documents: Retain complete additional copies of submittals on Project site to be submitted as record documents in accordance with requirements of Section 01 78 39 "Project Record Documents."
- L. Legibility: Provide clear and legible submittals. Submittals that are blurry or are for any reason unreadable will be returned without action.

## PART 2 - PRODUCTS

### 2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
  - 1. Post electronic submittals as PDF electronic files directly to Project Management Software Web site specifically established for Project.
    - a. Architect/Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
  - 2. Action Submittals: Submit three paper copies of each submittal to Architect/Engineer and one to University unless otherwise indicated. Architect/Engineer will return one copy.
  - 3. Informational Submittals: Submit two paper copies of each submittal to Architect/Engineer and one to University unless otherwise indicated. Architect/Engineer will not return copies.
  - 4. Certificates and Certifications Submittals: Provide a 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.
- 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 published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Manufacturer's printed recommendations.
    - e. Standard color charts.
    - f. Statement of compliance with specified referenced standards.
    - g. Statement of compliance with specified trade association standards.
    - h. Testing by recognized testing agency.
    - i. Application of testing agency labels and seals.
    - j. Notation of coordination requirements.
    - k. Notation of dimensions verified by field measurement.
  - 4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams showing factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.

- d. Rough-in diagrams and templates indicating clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before or concurrent with Samples.
  6. Confirm compliance of Product Data with requirements of Contract Documents. Submit cover letter indicating Contractor's certification of compliance.
  7. Submit additional copies of Product Data as required complying with requirements of Section 01 78 39 "Project Record Documents."
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Highlight, encircle or otherwise indicate deviations from Contract Documents. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect/Engineer's digital data drawing files is otherwise permitted. Standard information prepared without specific reference to the Project is not considered a shop drawing.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  2. 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 size of Construction Drawings.
  3. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
    - a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
    - b. Refer to Section 01 31 00 "Project Management and Coordination" for requirements for coordination drawings.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Mount, display or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match the Architect/Engineer's Sample.
  3. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of applicable Specification Section.
    - e. Specification paragraph number and generic name of each item.
    - f. Compliance with recognized standards.
    - g. Availability and delivery time.

4. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
  5. 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.
    - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect/Engineer will return submittal with options selected.
  6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or 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.
    - a. Number of Samples: Submit three sets of Samples. Architect/Engineer will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.
      - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
  7. 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 University's property, are the property of Contractor.
  8. Distribution of Samples: Prepare and distribute additional sets to Subcontractors, manufacturers, fabricators, suppliers, Installers, and others as required for performance of the Work. Show distribution on transmittal forms.
  9. Field Samples and Mock-Ups: Field Samples and mock-ups specified in individual Sections are full-size examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the Work will be judged.
- E. Selection of Related Materials: Where selections of colors, patterns, textures are specified to be made by Architect/Engineer, assemble complete samples of all specified or approved products for all Specification Sections and submit to Architect/Engineer. Review specifications and assemble all such samples for a combined single submittal. Indicate on the transmittal the latest date for selections to be made for each item to permit delivery of material in accordance with Progress Schedule. Architect/Engineer's action is limited solely to the specified selections or rejection of submittal items not in accordance with Specifications.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."

- G. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- L. LEED Submittals: For project required to obtain LEED certification, comply with requirements specified in Division 01 Section "Sustainable Design Requirements".
- M. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- N. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- O. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- P. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- Q. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- R. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- S. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- T. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. 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.
- U. Research Reports: Submit 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.
- V. Preconstruction Test Reports: Submit 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 in the Contract Documents.
- W. Compatibility Test Reports: Submit 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.
- X. Field Test Reports: Submit written reports 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 in the Contract Documents.
- Y. Design Data: Prepare and submit 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.

## 2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect/Engineer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, 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.
1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM File Incorporation: Incorporate delegated-design drawing and data files into Building Information Model established for Project.
1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions.



Mark with approval stamp before submitting to Architect/Engineer. Submittals received without Contractor's substantive review and approval stamp will be rejected and returned to the Contractor.

- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### 3.2 ARCHITECT/ENGINEER'S ACTION

- A. Action Submittals: Architect/Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect/Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Informational Submittals: Architect/Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect/Engineer will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect/Engineer.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect/Engineer without action.

**END OF SECTION 01 33 00**

## SECTION 01 35 44

### SPECIAL PROCEDURES FOR ENVIRONMENTAL HEALTH AND SAFETY AND FIRE AND LIFE SAFETY

#### 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 special administrative and procedural requirements related to environmental health and safety.
- B. University is Authority Having Jurisdiction (AHJ) for Fire and Life Safety. This responsibility is administered by the University's Fire and Life Safety Officer.
- C. Related Requirements:
  - 1. Section 01 35 46 "Indoor Air Quality Procedures" for procedure related to maintaining indoor air quality during construction.
  - 2. Section 02 81 00 "Transportation/Disposal of Hazardous Materials."

#### PART 2 - PRODUCTS (Not Used)

#### PART 3 - EXECUTION

##### 3.1 ENVIRONMENTAL HEALTH AND SAFETY AND FIRE AND LIFE SAFETY PROCEDURES

- A. Physical, Life, and Fire Safety:
  - 1. All contractors are required to conform to the Federal Occupational Safety and Health Administration (OSHA) regulations for construction (29 CFR 1926). Certain General Industry Standards (29 CFR 1910) may also apply, depending on location of work.
  - 2. Provide an effective health and safety program to control hazards, including but not limited to compressed gases, welding, electrical, safety netting, cranes, scaffolding and supplies on the roof.
  - 3. Provide fire protection in all construction areas to the satisfaction of the Authority Having Jurisdiction.
  - 4. During the construction phase, the Authority Having Jurisdiction may conduct oversight inspections to observe and provide recommendations regarding applicable safety standards. The following minimum items are included:
    - a. Do not block exit corridors. Install signage clearly identifying exit routes.
    - b. Provide physical barriers with appropriate warning signage to protect public areas from construction work.

- c. Conduct daily inspections to eliminate fire hazards and any other safety hazards.
- d. Periodic safety inspections will be performed on job sites by the Authority Having Jurisdiction. The Authority Having Jurisdiction for fire safety will present University's Project Manager with a written summary of the findings who will then take these issues to the Contractor's superintendent, foreman or other designated representative and return the summary form with documentation of the resolution of safety items to AHJ. Abate deficient items in a timely manner. Include documentation and resolution of safety items presented in weekly Progress Meeting minutes. Inspections by University AHJ are spot-checks only. They are not all encompassing. These inspections and recommendations do not relieve the Contractor from obligations related to safe work practices, as required under federal law.
- e. AHJ has the right to access the site at all times. Should a potential threat to personnel or property be observed, AHJ may require the hazard related operation immediately altered until adequate safeguards are addressed.
- f. Supply AHJ, through the University Project Manager, with a copy of Contractor's weekly safety meeting minutes and safety inspection reports.
- g. Provide signs used for proper identification of construction areas.
- h. Provide adequate number of appropriately rated fire extinguishers to be available on-site for emergency use in the construction area.
- i. Insure standpipes, pull stations, electrical panels, water control valves and fire hydrants are accessible at all times.
- j. Post emergency notification phone numbers provided by Contractor and University in all construction areas.
- k. Notify University Project Manager of any lost time injuries occurring on University's property within one (1) calendar day and of any fatalities immediately.
- l. Submit copies of all injury reports to AHJ, through University's Project Manager.
- m. Equip construction personnel with personal protective equipment (PPE) where required. Coordinate with University Project Manager to identify where use of PPE will be required.

B. OSHA Hazard Communication Standard:

1. Every Contractor and Subcontractor performing work shall to comply with the OSHA Hazard Communication Standard. Compliance includes joint University and Contractor responsibilities for the purpose of providing timely communications and information sharing with regard to hazardous materials, chemicals and chemical sources which may be present on-site or brought in by Contractor.
2. University Project Manager will provide Contractor with the following:
  - a. Information regarding known hazardous chemicals and agents or other hazards present at the job site.
  - b. University emergency procedures and contact numbers.
3. Provide safety training and environmental surveillance of all workers.
4. Inform and provide University's Project Manager the following:
  - a. Material safety data sheets (MSDS) for all chemicals introduced into the workplace.
  - b. Information regarding potential sources of pollutants which may be entrained in University's air intakes, e.g., roofing tar fumes, nuisance dusts, exhaust from internal combustion engines, welding or cutting fumes, and asbestos - if damaged or encountered during the course of the work.

C. Asbestos and Lead Paint:

1. The presence of asbestos-containing materials and/or paint containing lead on the job site does not mean a problem exists. Areas where asbestos is friable and not contained or lead paint is present or will be caused to be present in airborne or settled dust are of concern.

2. Responsibilities of University and Contractor regarding asbestos and lead paint are as follows:

a. University:

- 1) Notify the Contractor of the condition and location(s) where asbestos is known to be present or may reasonably be encountered, e.g., asbestos insulation, ceiling tiles, floor tiles, fire doors, wall and ceiling plasters, concrete, grouting, etc., and lead paint on metal building materials, walls, windows, etc.
- 2) Coordinate with Contractor when response action is required by a Subcontractor.
- 3) Contract with third party contractor to monitor areas where friable asbestos and/or lead-containing particles are present during construction/renovation projects for its own records and purpose. Monitoring results can be shared with Contractors but are in no way to be used for Contractor employee monitoring.
- 4) Final authority on all asbestos-related concerns and contractual arrangements.

b. Contractor:

- 1) Notify University's Project Manager of any suspected or existing problem involving asbestos or lead and cease work in that area until University has assessed the situation.
- 2) Ensure that undamaged asbestos-containing material and/or material containing lead, not included in the scope of the project, are not damaged.
- 3) Train and monitor their own employees, including Asbestos Awareness training and Lead Paint Awareness training, where applicable.
- 4) Be responsible for all environmental/industrial hygiene surveillance of its work staff and subcontractors and for required area monitoring where potential contamination of adjacent areas exists.
- 5) Prevent problems which can result in asbestos or lead exposure to building occupants.
- 6) Coordinate with the University's EHS Department and Building Maintenance and Operations through University's Project Manager and perform all activities that may potentially disturb asbestos containing materials in a manner acceptable to the EHS.
- 7) Follow State of Colorado regulation, Emission Standards for Asbestos, Part B, Control of Asbestos, "Regulation 8" and OSHA standards regulating exposure to asbestos and lead.
- 8) Where applicable, comply with Section 02 81 00 "Transportation/Disposal of Hazardous Materials."
- 9) Comply with current "Asbestos-Contaminated Soil Management Standard Operating Procedure Document, University of Colorado Anschutz Medical Campus" during excavation operations.

D. Carcinogens:

1. Contractor or any Subcontractor shall not knowingly install or cause to be installed any material or product containing carcinogens. Refer to Annual Report on Carcinogens, U.S. Department of Health and Human Services, National toxicology Program.

E. Hazardous Waste:

1. All hazardous wastes are to be handled and disposed of according to current EPA and CDPHE guidelines which can be obtained through University Project Manager. Only individuals specifically authorized by University may sign hazardous waste manifests for wastes generated on University's property. Only University approved transporters and disposal facilities are to be used for transportation and disposal of hazardous wastes.

- F. The Control of Hazardous Energy (Lockout/Tagout):
  - 1. Provide and enforce a program and procedures for the control of hazardous energy (lockout/tagout) including, but not limited to, locks, tags and lockout devices. Provide proof that workers have received safety training in the control of hazardous energy through lockout/tagout.
  
- G. Hot Work Operations:
  - 1. Comply with University hot work policy and obtain Hot Work Permit prior to executing any hot work in existing buildings.
  - 2. Notify University Project Manager prior to any hot work on University property.
  - 3. Provide and enforce a program to control fires during hot work operations. Provide appropriately rated fire extinguishers, fire retardant protective covers (when needed), and any other hot work related equipment.
  
- H. Confined Space Entry:
  - 1. Work in compliance with the “Confined Spaced Entry Procedure for Non-University Personnel” whenever any project requires entry into a confined space. A copy of this procedure can be obtained from University EHS through University’s Project Manager.
  
- I. Green Tagging of Work Area:
  - 1. Obtain a Green Tag and Construction Permit from the University Project Manager prior to any work being conducted in a laboratory or on any exhaust ductwork system serving a laboratory. If a Green Tag has been issued, it will be displayed at the entry of the laboratory area. The Green Tag assures that any radioactive, chemical or biological materials have been removed from the laboratory verifying the area is free from hazards to workers. If a Green Tag is not displayed, coordinate tagging with EHS through University’s Project Manager.
  
- J. Coronavirus / COVID-19
  - 1. Work in compliance with all current regulatory guidelines, CU Denver | Anschutz Medical Campus COVID-19 plan requirements, and university contractor COVID-19 plan requirements.
  - 2. Contact the university project manager for the current COVID-19 contractor plan. Contractor to return a completed university COVID-19 contractor plan along with a company COVID-19 plan.
  - 3. Contractor must receive plan acceptance from project manager prior to being granted access to the campus.
  - 4. Plan requirements are evolving, the university project manager will provide additional updates as necessary.

**END OF SECTION 01 35 44**

## SECTION 01 35 46

### INDOOR AIR QUALITY 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. Section includes administrative and procedural requirements for managing emissions and moisture control during construction.

##### 1.3 DEFINITIONS

- A. Sustainable Design Related Terminology: As defined is ASTM E 2114.
- B. Adequate Ventilation: Ventilation, including air circulation and air changes, required to cure materials, dissipate humidity, and prevent accumulation of particulates, dust, fumes, vapors, or gases.
- C. Hazardous Materials: Any material that is regulated as a hazardous material in accordance with 49 CFR 173, requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261. Throughout this specification, hazardous material includes hazardous chemicals.
  - 1. Hazardous materials include: pesticides, biocides, and carcinogens as listed by recognized authorities, such as the Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC).
- D. Indoor Air Quality (IAQ): The composition and characteristics of the air in an enclosed space that affect the occupants of that space. The indoor air quality of a space refers to the relative quality of air in a building with respect to contaminants and hazards and is determined by the level of indoor air pollution and other characteristics of the air, including those that impact thermal comfort such as air temperature, relative humidity and air speed.
- E. Interior Final Finishes: Materials and products that will be exposed at interior, occupied spaces including but not limited to flooring, wallcovering, finish carpentry, and ceilings.
- F. Packaged Dry Products: Materials and products that are installed in dry form and are delivered to the site in manufacturer's packaging including but not limited to carpets, resilient flooring, ceiling tiles, and insulation.
- G. Wet Products: Materials and products installed in wet form, including paints, sealants, adhesives, special coatings, and other materials which require curing.

#### 1.4 QUALITY ASSURANCE

- A. Inspection and Testing Lab Qualifications: Minimum of 5 years experience in performing the types of testing specified herein.

#### 1.5 PRECONSTRUCTION MEETING

- A. After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with University and Architect/Engineer to review and discuss the proposed IAQ Management Plan and develop a mutual understanding of detailed requirements for maintaining indoor air quality and environmental protection.

#### 1.6 SUBMITTALS

- A. Indoor Air Quality (IAQ) Management Plan: Not less than 10 business days before the Pre-construction meeting, prepare and submit an IAQ Management Plan including, but not limited to, the following:

1. Procedures for control of emissions during construction.
  - a. Identify schedule for application of interior finishes.
2. Procedures for moisture control during construction.
  - a. Identify porous materials and absorptive materials.
  - b. Identify schedule for inspection of stored and installed absorptive materials.
3. Revise and resubmit Plan as required by University.
  - a. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

- B. Product Data:

1. Submit product data for filtration media used during construction and during operation. Include Minimum Efficiency Reporting Value (MERV).
2. Submit air pressure difference maps for each mode of operation of HVAC.
3. Material Safety Data Sheets: Submit MSDSs for inclusion in Operation and Maintenance Manual for the following products. Coordinate with Section 01 78 23 – Operation and Maintenance Data.
  - a. Adhesives.
  - b. Floor and wall patching/leveling materials.
  - c. Caulking and sealants.
  - d. Insulating materials.
  - e. Fireproofing and firestopping.
  - f. Carpet.
  - g. Paint.
  - h. Clear finish for wood surfaces.
  - i. Lubricants.
  - j. Cleaning products.

- C. Inspection and Test Reports:

1. Moisture control inspections.

2. Moisture content testing.
3. Moisture penetration testing.
4. Microbial growth testing.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 IAQ MANAGEMENT - EMISSIONS CONTROL

- A. Provide point person responsible for the implementation and assurance that the Indoor Air Quality Plan is being implemented.
- B. University Indoor Air Quality Plan: Comply with the requirements of the University IAQ Plan, latest version, appended to this Specification Section.
- C. Flush-Out: After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%.

### 3.2 IAQ MANAGEMENT - MOISTURE CONTROL

- A. Housekeeping:
  1. Keep materials dry. Protect stored on-site and installed absorptive materials from moisture damage.
  2. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.
  3. Install interior absorptive materials only after building envelope is sealed and weatherproofed.
- B. Inspections: Document and report results of inspections; state whether or not inspections indicate satisfactory conditions.
  1. Examine materials for dampness as they arrive. If acceptable to University, dry damp materials completely prior to installation; otherwise, reject materials that arrive damp.
  2. Examine materials for mold as they arrive and reject materials that arrive contaminated with mold.
  3. Inspect stored and installed absorptive materials regularly for dampness and mold growth. Inspect weekly.
    - a. Where stored on-site or installed absorptive materials become wet, notify Architect/Engineer and University. Inspect for damage. If acceptable to University, dry completely prior to closing in assemblies; otherwise, remove and replace with new materials.
  4. Basement: Monitor basement and crawlspace humidity, and dehumidify when relative humidity is greater than 85 percent for more than 2 weeks or at the first sign of mold growth.
  5. Site drainage: Verify that final grades of site work and landscaping drain surface water and ground water away from the building.
  6. Weather-proofing: Inspect moisture control materials as they are being installed. Include the following:



- a. Air and weather-resistive barrier: Verify air and weather-resistive barrier is installed without punctures and/or other damage. Verify air barrier and weather-resistive is sealed completely.
  - b. Flashing: Verify correct shingling of the flashing for roof, walls, windows, doors, and other penetrations.
  - c. Insulation layer: Verify insulation is installed without voids.
  - d. Roofing: In accordance with ASTM D7186 Standard Practice for Quality Assurance Observation of Roof Construction and Repair
7. Plumbing: Verify satisfactory pressure test of pipes and drains is performed before closing in and insulating lines.
  8. HVAC: Inspect HVAC system as specified in Section 23 08 00 – Commissioning.
    - a. And, inspect HVAC to verify:
      - 1) Condensate pans are sloped and plumbed correctly.
      - 2) Access panels are installed to allow for inspection and cleaning of coils and ductwork downstream of coils.
      - 3) Ductwork and return plenums are air sealed.
      - 4) Duct insulation is installed and sealed.
      - 5) Chilled water line and refrigerant line insulation are installed and sealed.
- C. Schedule:
1. Schedule work such that absorptive materials, including but not limited to porous insulations, paper-faced gypsum board, ceiling tile, and finish flooring, are not installed until they can be protected from rain and construction-related water.
  2. Weather-proof as quickly as possible. Schedule installation of moisture-control materials, including but not limited to air and weather-resistive barriers, flashing, exterior sealants and roofing, at the earliest possible time.
- D. Testing for Moisture Content: Test moisture content of porous materials and absorptive materials to ensure that they are dry before sealing them into an assembly. Document and report results of testing. Where tests are not satisfactory, dry materials and retest. If satisfactory results cannot be obtained with retest, remove and replace with new materials.
1. Concrete: Moisture test prior to finish flooring application as specified in Division 09.
  2. Wood: Moisture test as per ASTM D4444 - Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters; unless otherwise indicated acceptable upper limits for wood products are < 20% at center of piece; < 15% at surface.
  3. Gypsum Board, Gypsum Plaster, Insulation, and other absorptive materials: Moisture test with a Pinless Moisture Meter to assess patterns of moisture, if any.
- E. Testing for Moisture Penetration:
1. Windows: Test as per ASTM E1105 Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference at 100 percent static-air-pressure difference specified in applicable Division 08 Sections; unless otherwise indicated, acceptable upper limits are no leakage for 15 minutes.
    - a. Number of Tests: 1 percent of openings but not less than two.

2. Horizontal Waterproofing (not roofing): Test as per ASTM D5957 Standard Guide for Flood Testing Horizontal Waterproofing Installations; acceptable upper limits are no leakage for 15 minutes.
    - a. Test frequency: 100 percent of horizontal waterproofed surfaces.
  3. Masonry: Test as per ASTM C1601 Standard Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces; acceptable upper limits are no leakage for 15 minutes.
  4. Exterior Walls:
    - a. Air tightness of the enclosure test: ASTM E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization or ASTM E1827
      - 1) Air Leakage: The mean value of the air leakage flow rate calculated from measured data at 0.3 in wg (75 Pa) must not exceed 0.25 cu ft/ minute per square foot of envelope area. Measurements must be referenced at standard conditions of 14.696 psi (101.325 KPa) and 68 deg F.
- F. Testing for Support of Microbial Growth: Test and report in accordance with ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers. Indicate susceptibility of product or material to colonization and amplification of microorganisms. Identify microorganisms and conditions of testing.
1. Normal conditions: Perform testing at 35 degrees Centigrade and 50 percent relative humidity.
  2. Extreme conditions: Perform worst case scenarios screening tests by providing an atmosphere where environmental conditions may be favorable for microbial growth.
  3. Perform testing for the following:
    - a. Fireproofing material on appropriate substrate.
    - b. Ceiling tile.
    - c. Wall covering.
    - d. Other appropriate material.

**END OF SECTION 01 35 46**



## SECTION 01 40 00

### 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. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect/Engineer, University, or authorities having jurisdiction are not limited by provisions of this Section.
  - 4. Specific test and inspection requirements are not specified in this Section.
- C. Related Requirements:
  - 1. Section 01 42 00 "Reference" for list of references, standards and definitions.
  - 2. Section 01 91 13 "General Commissioning" for coordination of testing with commissioning activities.
  - 3. Division 23 for testing, adjusting and balancing of mechanical systems.
  - 4. Division 26 for testing of electrical systems.

##### 1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect/Engineer.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities

of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. As indicated in individual Specifications Sections or on the Drawings, the Work may include the following types of mockups:
    - a. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
    - b. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
    - c. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
  - D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
  - E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
  - F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
  - G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
  - H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
  - I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
    1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
  - J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- 1.4 CONFLICTING REQUIREMENTS
- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.

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

#### 1.5 ACTION SUBMITTALS

- A. Shop Drawings: Where integrated exterior mockups are required and indicated on the Drawings, provide plans, sections, and elevations, indicating materials and size of mockup construction.
  - 1. Indicate manufacturer and model number of individual components.
  - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
  - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect/Engineer.
  - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect/Engineer.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  - 1. Specification Section number and title.
  - 2. Entity responsible for performing tests and inspections.
  - 3. Description of test and inspection.
  - 4. Identification of applicable standards.
  - 5. Identification of test and inspection methods.
  - 6. Number of tests and inspections required.
  - 7. Time schedule or time span for tests and inspections.
  - 8. Requirements for obtaining samples.
  - 9. Unique characteristics of each quality-control service.

#### 1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.
  - 6. Description of the Work and test and inspection method.

7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical 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.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
  2. Statement that equipment complies with requirements.
  3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  4. Statement whether conditions, products, and installation will affect warranty.
  5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For University'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.
- 1.8 QUALITY ASSURANCE
- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
1. Monitor quality control over products, services, site conditions, and workmanship to produce work of specified quality.
  2. Comply fully with manufacturers' instructions, including each step in sequence.
  3. If manufacturers' instructions conflict with Contract Document requirements, request clarification from Architect/Engineer before proceeding.
  4. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
  5. Perform work by persons qualified to produce workmanship of specified quality.

- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **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.
- D. **Subcontractor and 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. In addition comply with the following:
  - 1. For all trades: Proof of applicable licensing.
  - 2. Electrical contractors:
    - a. Company: State of Colorado master electrician license.
    - b. On-site electricians: State of Colorado journeyman license.
  - 3. Plumbing Contractors:
    - a. Company: State of Colorado master plumbers license.
    - b. On-site plumbers: State of Colorado journeyman license.
    - c. Gas piping installations: State of Colorado master plumber with minimum 5 years institutional or heavy commercial gas piping experience. Provide an on-site supervisor with a minimum of 3 years of supervisory experience.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections 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. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329 or ASTM D 3740 as appropriate; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
  - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
  - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
  - 3. Independent Agency: Meeting "Recommended Requirements for Independent Laboratory Qualifications" published by American Council for Independent Laboratories.
  - 4. Authorized to operate in the State of Colorado.
  - 5. Calibrate testing equipment at reasonable intervals with devices of accuracy traceable to National Bureau of Standards or of accepted values of natural physical constants.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.



- I. **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.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. **Contractor responsibilities include the following:**
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    - d. When required, build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
    - e. When required, build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups, as applicable; do not reuse products on Project.
  - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect/Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. **Mockups:** 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 Architect/Engineer.
  - 2. Notify Architect/Engineer seven calendar days in advance of dates and times when mockups will be constructed.
  - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
  - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
  - 5. Obtain Architect/Engineer's approval of mockups before starting work, fabrication, or construction.
    - a. Allow seven calendar days for initial review and each re-review of each mockup.
  - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 7. Demolish and remove mockups when directed unless otherwise indicated.
- L. **Integrated Exterior Mockups:** When indicated on Drawings, construct integrated exterior mockup. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.
- M. **Room Mockups:** When indicated on Drawings, construct room mockups incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Architect/Engineer to evaluate quality of the Work. Provide room mockups of the following rooms:

- N. Laboratory Mockups: When required by individual Specification Sections, comply with requirements of preconstruction testing and those specified in individual Specification Sections.

## 1.9 QUALITY CONTROL

- A. University Responsibilities: Where quality-control services are indicated as University's responsibility, University will engage a qualified testing agency to perform these services.
  - 1. University will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  - 2. Payment for these services will be made by the University.
  - 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to University are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
  - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by University, unless agreed to in writing by University.
  - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  - 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect/Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect/Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples including, but not limited to, safe storage and proper curing of concrete test cylinders at Project site for first 24 hours after casting as required by ASTM C 31.
  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.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Manufactured Items and Equipment: Where manufactured products or equipment are required to have representative samples tested, do not use such materials or equipment until tests have been made and the materials or equipment found to be acceptable. Do not incorporate in the work any product which becomes unfit for use after acceptance.
- J. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to University, Architect/Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.
- 1.10 SPECIAL TESTS AND INSPECTIONS
- A. Special Tests and Inspections: University will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of University, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.

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

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections including instructions received from University. Include the following:
  1. Date test or inspection was conducted.
  2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Architect/Engineer.
  4. Identification of testing agency or special inspector conducting test or inspection.
  5. Disposition: Pass, fail, nature of defects, if any.
  6. Date and descriptions of remedial or correction action taken.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect/Engineer's reference during normal working hours.

### 3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- 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.

### 3.3 SCHEDULE OF INSPECTIONS AND TESTS BY UNIVERSITY

- A. University will engage testing agency and pay for testing and inspection associated with the following materials and systems, where included in the Project:
  1. Compaction density of fill and backfill.

2. Drilled pier end bearing conditions and depths.
3. Cast-in-place concrete.
4. Precast concrete.
5. Post-tensioned concrete tendons.
6. Masonry.
7. Structural steel field welds and bolted connections.
8. Spray-applied fireproofing.
9. Built-up roof cutouts.
10. Asphaltic concrete paving.
11. Foundation drainage systems.
12. Drainage structures and piping.
13. Waterproofing.
14. Air barriers.
15. Fluid applied membranes.
16. Thermal imaging.
17. Curtain wall, window, and door field testing.
18. Ceiling hanger wire pull-out.
19. Electrical resistance of static-control resilient flooring.
20. Field sound testing of operable partitions.
21. Elevator safety.
22. Fan vibration.

**END OF SECTION 01 40 00**

## SECTION 01 41 00

### REGULATORY 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. Section Includes:
  - 1. Building Department Authority.
  - 2. MS 4 Storm Water and Water Quality Permits
  - 3. Applicable Codes and Standards.

##### 1.3 BUILDING DEPARTMENT AUTHORITY

- A. The University of Colorado Denver is charged with the responsibility of ensuring that provision of applicable codes, standards and guidelines are met on its campuses.
- B. The University Denver campus has an established Building Authority responsible to review and examine buildings and plan documents, to permit and inspect construction and/or demolition to ensure conformance to codes adopted by the University and issue certificates of temporary occupancy and occupancy if satisfactory conformance is demonstrated.
- C. The authority is executed by the Campus Building Official (CBO) who has the responsibility to perform all the duties set forth in the Current Approved State Buildings Codes and other applicable codes and standards indicated in the "Applicable Codes and Standards" Article of this Section.
- D. Permits: Obtain a separate permit for each Project from the Office of the CBO prior to erecting, constructing, enlarging, repairing, moving, removing, converting or demolishing any building or portion thereof. Coordinate and obtain all permits through the University Project Manager. The Contractor is not responsible for costs associated with construction permits.
  - 1. Exempt work: A building permit is not required for the following:
    - a. Fences less than or equal to 6 feet tall.
    - b. Movable casework, counters and partitions not over 5 feet 9 inches tall with no electrical or plumbing.
    - c. Platforms, walks, and driveways not more than 30 inches above grade and not over any basement or story below.
    - d. Painting, papering and similar finish work.
    - e. Other work of limited scope at the discretion of the CBO.
- E. Permit Issuance: The CBO, or at the discretion of the CBO a third party code consultant, will review application, Drawings, Specifications, computations and other data filed for permit. Complete the permit

application with the University Project Manager. Permits require submittal of two (2) stamped, signed sets of Construction Documents, including Drawings, Specifications and all Addenda, and one (1) set of each engineering discipline's calculations, where such calculations are required. If CBO determines that submittal conforms to the requirements of the Building Code and other applicable codes, standards, laws, regulations and ordinances, an inspection record card will be issued with the building permit. Keep one stamped set of documents on site. The University will keep one stamped set in the Campus Support plan room.

- F. Suspension or Revocation of Permit: CBO may, in writing, suspend or revoke a permit issued in error or on the basis of submitted information that is incorrect or that is in violation of the Building Code and other applicable codes and standards.
- G. Posting of Permit: Post the Permit in a visible and protected location near the access to the project.
- H. Inspection Record Card: Post the Inspection Record Card next to the permit in a visible and protected location near the access to the project. CBO will make required entries based on inspection of the work.
- I. Inspection Requests:
  - 1. Notify CBO that work is ready for inspection two business days before such inspection is desired by telephoning the number posted on the permit. The CBO retains the right to require requests in writing.
  - 2. A re-inspection fee may be charged for prior rejected items.
- J. Construction Inspections:
  - 1. Contractor is not responsible for costs associated with construction inspections, except re-inspections. The CBO or his/her designee will perform all general building, electrical and plumbing inspections. All construction or work for which a permit is required must remain accessible and exposed for inspection purposes. Provide access to and means for inspection of work.
  - 2. Site Utilities: Contact and comply with all requirements of City of Aurora.
  - 3. Plumbing and Electrical Inspections: For new buildings and major additions, contact and comply with all requirements of State of Colorado Plumbing and Electrical Boards.
  - 4. Provisions for structural and other special inspections required by Contract Documents, current approved State Building Codes and University Codes will be provided by the University.
- K. Certification of Occupancy:
  - 1. When CBO inspects the project and finds no violations of any provision of the Building Code, other applicable codes, standards, laws, regulations and ordinances, CBO will issue a Certification of Occupancy (CO) which will contain the following:
    - a. Building permit number.
    - b. Address of building.
    - c. Name and address of Owner.
    - d. Description of building or portion thereof for which certification is issued.
    - e. Statement that described building or portion thereof has been inspected for compliance with the requirements of the Building Code, other applicable codes, standards, laws, regulations and ordinances, as relates to type of occupancy and use for which the building is intended.

2. Temporary Certificate of Occupancy (TCO): If CBO finds no substantial hazard will result from occupancy of any building or portion thereof before the same is completed, CBO may issue a TCO for the use of a portion or portions of a building or structure prior to the completion of the entire building or structure.
3. Posting of CO: Provide a copy to the University Project Manager and post in a conspicuous location on the premises. CO may not be removed except by CBO upon initial occupancy.
4. Revocation of CO:

#### 1.4 MS4 STORM WATER AND WATER QUALITY PERMITS

- A. The University has a non-standard MS4 permit for entire Anschutz Medical Campus (AMC) that requires University over-sight of campus construction and its water quality impact. Contractors are required to prepare Storm Water Quality Plans and obtain State of Colorado CDPHE permits for all projects that impact site. In addition, Contractors shall comply with the University MS4 permit requirements, including keeping written record of weekly inspections of Storm Water Quality measures and attaching record to the weekly Progress Meeting minutes. Submit the plan, permits, and evidence of final closeout to University Project Manager who will copy all such storm water documents to University Engineering Department. Coordinate with University Project Manager who will arrange for University Grounds Manager to attend monthly inspections and closeout walk.

#### 1.5 APPLICABLE CODES AND STANDARDS

- A. The following approved building codes and standards have been adopted by State Buildings Programs (SBP) as the minimum requirements to be applied to all state-owned buildings and physical facilities including capital construction and controlled maintenance construction projects. Current applicable codes can be obtained from The Office of the State Architect's website.
- B. University of Colorado Denver Codes and Standards: The following codes and standards supplement those indicated on the Office of the State Architect website.
  1. The Manual of Guidelines and Standards for Construction Projects
    - a. <http://ucdenver.edu/about/departments/FacilitiesManagement/FacilitiesProjects/Pages/GuidelinesStandards.aspx>
    2. Colorado Rules and Regulations pertaining to Radiation Control, 6 CCR 1007 Part 1-20.
    3. Colorado Rules and Regulations pertaining Air Quality Control Commission Regulations, 5 CCR 1001-10, Part B "Asbestos Control."
    4. Colorado Rules and Regulations pertaining to Solid Waste, 6 CCR 1007-2.
    5. Colorado Rules and Regulations pertaining to Hazardous Waste, 6 CCR 1007-3.
    6. Federal Hazardous Waste Regulations, 40 CFR, Parts 260 through 264.
    7. Federal Clean Water Act (CWA) is 33 U.S.C § 1251 et seq. (1972).
    8. University of Colorado Denver | Anschutz Medical Campus, Asbestos Contaminated Soil Management, Standard Operating Procedure (SOP) Document.
    9. NFPA 30: Flammable and Combustible Liquids Code.
    10. NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals.
    11. NFPA 72: National Fire Alarm and Signaling Code.
    12. Life Safety Code (NFPA 101) – latest edition.
      - a. Use the most restrictive interpretation where NFPA 101 conflicts with the IBC requirements.



13. ANSI/AIHA Z9.5 Laboratory Ventilation – latest edition.
    - a. <http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx>
  14. ANSI/AIHA Z9.6 Exhaust Systems for Grinding, Buffing and Polishing – latest edition.
    - a. <http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx>
  15. ANSI/AIHA Z9.10 Fundamentals Governing the Design and Operation of Dilution Ventilation Systems in Industrial Occupancies – latest edition.
    - a. <http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx>
  16. ANSI/ASHRAE/ASHE Standard 170 – Ventilation of Healthcare Facilities – latest edition.
  17. ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality.
  18. OSHA “Safety and Health Regulation for Construction” (29 CFR 1926).
  19. OSHA “Occupational Safety and Health Standards” (29 CFR 1910).
  20. American Institute of Architects, Academy of Architecture for Health (AIA AAHA) and Facility Guidelines Institute (FGI), Guidelines for Design and Construction of Hospital and Healthcare Facilities – latest edition (FOR PATIENT CARE AREAS ONLY).
  21. CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL); latest edition.
  22. NIH Design Requirements Manual (DRM) – latest edition.
    - a. <http://orf.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/DesignRequirementsManualPDF.htm>
  23. NIH Guidelines for Research Involving Recombinant DNA Molecules – latest edition.
  24. ILAR Guide for Care and Use of Laboratory Animals - latest edition.
  25. National Research Council of the National Academies, Institute for Laboratory Animal Research, Division on Earth and Life Studies: Guide for the Care and Use of Laboratory Animals - latest edition.
  26. Uniform Federal Accessibility Standards (UFAS) – latest edition.
  27. Metro Wastewater District’s Rules and Regulations, (Sections 6.17 [6.13, 6.14] and 6.18).
  28. City of Aurora Asphalt and Paving Standards - latest edition.
- C. Other Standards: As indicated in individual Specification Sections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 41 00**

## SECTION 01 42 00

### 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 SUMMARY

- A. Section Includes:

1. Definitions.
2. Industry Standards.
3. Abbreviations and Acronyms.

- B. Related Requirements:

1. Section 01 10 00 "Summary" for an explanation of specification and drawing conventions.
2. Section 01 41 00 "Regulatory Requirements" for a list of applicable codes.

##### 1.3 DEFINITIONS

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

1. Definitions in this Section are not intended to be complete, exhaustive or exclusive. They are general and apply to the Work to the extent that such definitions are not stated more explicitly in other provisions of the Contract Documents.

- B. "Approved": When used to convey Architect/Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract. Except where expressly indicated, such approval does not release the Contractor from responsibility to fulfill requirements of the Contract Documents.

- C. "Backup": N+1 system.

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

- E. "EHS": Environmental Health and Safety.

- F. "Engineer": Architect/Engineer. Other terms including "Mechanical Engineer", "Electrical Engineer", or "Structural Engineer" have the same meaning as "Engineer."

- G. "General Conditions": Contract terms contained in Contractor's Agreement Design/Bid/Build, State Form SC-6.21 and The General Conditions of the Construction Contract Design/Bid/Build, State Form SC-6.23

- H. "General Requirements": Provisions and requirements of all Division 01 Sections as they apply to all aspects of the Work.
- I. "Guarantee": The narrow definition of the term "warranty" applying to both "warranty" and "guarantee" which terms are used interchangeably.
- J. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- K. "Redundant": 2N system. The level of redundancy is determined by design.
- L. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work, whether lawfully imposed by authorities having jurisdiction or not.
- M. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- N. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- O. "Owner": Principal Representative and/or University.
- P. "Provide": Furnish and install, complete and ready for the intended use.
- Q. "Project Manual": Bound, printed volume or volumes including Conditions of the Contract and Specifications, which may also include bidding requirements, contract forms, details, schedules, surveys, reports or other relevant items that may or may not be Contract Documents.
- R. "Project Site": Space available for performing construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.
- S. "Supplementary Conditions": University Special Supplementary General Conditions. Other terms including "Supplementary General Conditions" shall have the same meaning.

#### 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 as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
  - 1. Referenced standards take precedence over standards that are not referenced but generally recognized in the construction industry as applicable.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents.
  - 1. Updated Codes and Standards: Where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected, submit Contractor-Initiated Change Order Bulletin and Change Order Proposal in accordance with

Section 01 26 00 “Contract Modification Procedures” for consideration to modify contract requirements to comply with revised code or standard.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
  - 2. Where required by individual Specification Sections provide and maintain copies of referenced codes and standards at Project Site.
  - 3. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Architect/Engineer reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.
- D. Unreferenced Standards: Unreferenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with recognized construction industry standards.
- E. Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Architect/Engineer 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 sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AABC	Associated Air Balance Council www.aabc.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.americanbearings.org	(202) 367-1155
ACI	American Concrete Institute (Formerly: ACI International) www.concrete.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The)	(205) 257-2530

	www.aeic.org	
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The) www.ahrinet.org	(703) 524-8800
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. www.aosaseed.com	(607) 256-3313
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)	
ARI	American Refrigeration Institute (See AHRI)	
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917

ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (American Society of Mechanical Engineers) www.asme.org	(800) 843-2763 (973) 882-1170
ASSE	American Society of Safety Engineers (The) www.asse.org	(847) 699-2929
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions www.atis.org	(202) 628-6380
AWEA	American Wind Energy Association www.awea.org	(202) 383-2500
AWI	Architectural Woodwork Institute www.awinet.org	(571) 323-3636
AWMAC	Architectural Woodwork Manufacturers Association of Canada www.awmac.com	(403) 453-7387
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association) www.awpa.com	(205) 733-4077
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.gobrick.com	(703) 620-0010
BICSI	BICSI, Inc. www.bicsi.org	(800) 242-7405 (813) 979-1991

BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
BOCA	BOCA (Building Officials and Code Administrators International Inc.) (See ICC)	
BWF	Badminton World Federation (Formerly: International Badminton Federation) www.bwfbadminton.org	60 3 9283 7155
CDA	Copper Development Association www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.electricity.ca	(613) 230-9263
CEA	Consumer Electronics Association www.ce.org	(866) 858-1555 (703) 907-7600
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CFSEI	Cold-Formed Steel Engineers Institute www.cfsei.org	(866) 465-4732 (202) 263-4488
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(404) 622-0073
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(703) 724-1128
CRI	Carpet and Rug Institute (The) www.carpet-rug.org	(706) 278-3176
CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(800) 328-6306 (847) 517-1200

CSA	Canadian Standards Association www.csa.ca	(800) 463-6727 (416) 747-4000
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(866) 797-4272 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
CWC	Composite Wood Council (See CPA)	
DASMA	Door and Access Systems Manufacturers Association www.dasma.com	(216) 241-7333
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
ECA	Electronic Components Association www.ec-central.org	(703) 907-8024
ECAMA	Electronic Components Assemblies & Materials Association (See ECA)	
EIA	Electronic Industries Alliance (See TIA)	
EIMA	EIFS Industry Members Association www.eima.com	(800) 294-3462 (703) 538-1616
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association (Electrostatic Discharge Association) www.esda.org	(315) 339-6937
ESTA	Entertainment Services and Technology Association (See PLASA)	
EVO	Efficiency Valuation Organization www.evo-world.org	(415) 367-3643 44 20 88 167 857
FIBA	Fédération Internationale de Basketball (The International Basketball Federation) www.fiba.com	41 22 545 00 00



FIVB	Fédération Internationale de Volleyball (The International Volleyball Federation) www.fivb.org	41 21 345 35 45
FM Approvals	FM Approvals LLC www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridarroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council U.S. www.fscus.org	(612) 353-4511
GA	Gypsum Association www.gypsum.org	(301) 277-8686
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GS	Green Seal www.greenseal.org	(202) 872-6400
HI	Hydraulic Institute www.pumps.org	(973) 267-9700
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association (See AHRI)	
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAPSC	International Association of Professional Security Consultants www.iapsc.org	(415) 536-0288
IAS	International Approval Services (See CSA)	
ICBO	International Conference of Building Officials (See ICC)	
ICC	International Code Council www.iccsafe.org	(888) 422-7233 (202) 370-1800

ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICPA	International Cast Polymer Alliance www.icpa-hq.org	(703) 525-0511
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America) www.ies.org	(212) 248-5000
IESNA	Illuminating Engineering Society of North America (See IES)	
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 981-0100
IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
IGSHPA	International Ground Source Heat Pump Association www.igshpa.okstate.edu	(405) 744-5175
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
Intertek	Intertek Group (Formerly: ETL SEMCO; Intertek Testing Service NA) www.intertek.com	(800) 967-5352
ISA	International Society of Automation (The) (Formerly: Instrumentation, Systems, and Automation Society) www.isa.org	(919) 549-8411
ISAS	Instrumentation, Systems, and Automation Society (The) (See ISA)	
ISFA	International Surface Fabricators Association (Formerly: International Solid Surface Fabricators Association) www.isfanow.org	(877) 464-7732 (801) 341-7360
ISO	International Organization for Standardization www.iso.org	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association (See ISFA)	

ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association (See CPA)	
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(847) 375-4718
MFMA	Maple Flooring Manufacturers Association, Inc. www.maplefloor.org	(888) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. www.metalframingmfg.org	(312) 644-6610
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association) www.wmmpa.com	(800) 550-7889 (530) 661-9591
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937 (604) 298-7578
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.org	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(630) 942-6591
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(800) 797-6223 (281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848

NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (269) 488-6382
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFPA	NFPA International (See NFPA)	
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NHLA	National Hardwood Lumber Association www.nhla.com	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association (See NWFA)	
NOMMA	National Ornamental & Miscellaneous Metals Association www.nomma.org	(888) 516-8585
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010

NSPE	National Society of Professional Engineers www.nspe.org	(703) 684-2800
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The) www.ntma.com	(800) 323-9736
NWFA	National Wood Flooring Association www.nwfa.org	(800) 422-4556 (636) 519-9663
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (978) 557-0720
PLASA	PLASA (Formerly: ESTA - Entertainment Services and Technology Association) www.plasa.org	(212) 244-1505
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute www.rfci.com	(706) 882-3833
RIS	Redwood Inspection Service www.redwoodinspection.com	(925) 935-1499
SAE	SAE International (Society of Automotive Engineers) www.sae.org	(877) 606-7323 (724) 776-4841
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	
SCTE	Society of Cable Telecommunications Engineers www.scte.org	(800) 542-5040 (610) 363-6888
SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabs.com	(877) 294-5424 (516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	

SIA	Security Industry Association www.siaonline.org	(866) 817-8888 (703) 683-2075
SJI	Steel Joist Institute www.steeljoist.org	(843) 293-1995
SMA	Screen Manufacturers Association www.smainfo.org	(773) 636-0672
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SMPTE	Society of Motion Picture and Television Engineers www.smpte.org	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau www.spib.org	(850) 434-2611
SPRI	Single Ply Roofing Industry www.spri.org	(781) 647-7026
SRCC	Solar Rating and Certification Corporation www.solar-rating.org	(321) 638-1537
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWPA	Submersible Wastewater Pump Association www.swpa.org	(847) 681-1868
TCA	Tilt-Up Concrete Association www.tilt-up.org	(319) 895-6911
TCNA	Tile Council of North America, Inc. (Formerly: Tile Council of America) www.tileusa.com	(864) 646-8453
TEMA	Tubular Exchanger Manufacturers Association, Inc. www.tema.org	(914) 332-0040
TIA	Telecommunications Industry Association (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance) www.tiaonline.org	(703) 907-7700

TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance (See TIA)	
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute www.tpinst.org	(703) 683-1010
TPI	Turfgrass Producers International www.turfgrassod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tilerroofing.org	(312) 670-4177
UBC	Uniform Building Code (See ICC)	
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association www.wcmanet.org	(212) 297-2122
WDMA	Window & Door Manufacturers Association www.wdma.com	(800) 223-2301 (312) 321-6802
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association (See MMPA)	
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 938-5441

WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930
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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 sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN	Deutsches Institut für Normung e.V. www.din.de	49 30 2601-0
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IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
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ICC	International Code Council www.iccsafe.org	(888) 422-7233
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ICC-ES	ICC Evaluation Service, LLC www.icc-es.org	(800) 423-6587 (562) 699-0543
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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 sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE	Army Corps of Engineers www.usace.army.mil	(202) 761-0011
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CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
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DOC	Department of Commerce National Institute of Standards and Technology www.nist.gov	(301) 975-4040
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DOD	Department of Defense http://dodssp.daps.dla.mil	(215) 697-2664
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DOE	Department of Energy www.energy.gov	(202) 586-9220
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EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
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FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
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FG	Federal Government Publications www.gpo.gov	(202) 512-1800
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GSA	General Services Administration www.gsa.gov	(800) 488-3111 (202) 619-8925
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HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
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LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division <a href="http://eetd.lbl.gov">http://eetd.lbl.gov</a>	(510) 486-4000
OSHA	Occupational Safety & Health Administration <a href="http://www.osha.gov">www.osha.gov</a>	(800) 321-6742
SD	Department of State <a href="http://www.state.gov">www.state.gov</a>	(202) 647-4000
TRB	Transportation Research Board National Cooperative Highway Research Program <a href="http://www.trb.org">www.trb.org</a>	(202) 334-2934
USDA	Department of Agriculture Agriculture Research Service U.S. Salinity Laboratory <a href="http://www.ars.usda.gov">www.ars.usda.gov</a>	(202) 720-3656
USDA	Department of Agriculture Rural Utilities Service <a href="http://www.usda.gov">www.usda.gov</a>	(202) 720-2791
USDJ	Department of Justice Office of Justice Programs National Institute of Justice <a href="http://www.ojp.usdoj.gov">www.ojp.usdoj.gov</a>	(202) 307-0703
USP	U.S. Pharmacopeia <a href="http://www.usp.org">www.usp.org</a>	(800) 227-8772 (301) 881-0666
USPS	United States Postal Service <a href="http://www.usps.com">www.usps.com</a>	(202) 268-2000

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CFR	Code of Federal Regulations Available from Government Printing Office <a href="http://www.gpo.gov/fdsys">www.gpo.gov/fdsys</a>	(866) 512-1800 (202) 512-1800
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point <a href="http://dodssp.daps.dla.mil">http://dodssp.daps.dla.mil</a>	(215) 697-2664
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification	(215) 697-2664

Available from Department of Defense Single Stock Point  
<http://dodssp.daps.dla.mil>

Available from Defense Standardization Program  
[www.dsp.dla.mil](http://www.dsp.dla.mil)

Available from General Services Administration (800) 488-3111  
[www.gsa.gov](http://www.gsa.gov) (202) 619-8925

Available from National Institute of Building Sciences/Whole Building  
Design Guide (202) 289-7800  
[www.wbdg.org/ccb](http://www.wbdg.org/ccb)

MILSPEC Military Specification and Standards  
(See DOD)

USAB United States Access Board (800) 872-2253  
[www.access-board.gov](http://www.access-board.gov) (202) 272-0080

USATBCB U.S. Architectural & Transportation Barriers Compliance Board  
(See USAB)

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 42 00**



## SECTION 01 50 00

### 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. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
  - 1. Nothing in this Section is intended to limit types and amounts of temporary work required, and no omission from this Section will be recognized as an indication by Architect/Engineer that such temporary activity is not required for successful completion of the Work. The use of alternative facilities equivalent to those specified is the Contractor's option, subject to Architect/Engineer's and University acceptance.
- B. Related Requirements:
  - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.
  - 2. Section 01 35 46 "Indoor Air Quality" for temporary facility work including HVAC, air filtration, moisture management, air filtration and dust control partitions required to comply with indoor air quality requirements during construction.

##### 1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, University's construction forces, Architect/Engineer, testing agencies, and authorities having jurisdiction.
- B. Use Charges: As follows:
  - 1. For new construction: Arrange for and pay for water, sewer, electric power, steam and chilled water use charges for utility usage by all entities for construction operations.
  - 2. For renovations of existing facilities: Arrange for and University will pay for all use charges.
- C. Temporary Metering: For all utility connection; sub-meter at point of connection to existing systems.
  - 1. Temporary utility meter must be approved by University Campus Energy Engineer.
  - 2. Meters shall be operational prior to any use of utility for temporary heating.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
  - 1. Locations of dust-control partitions at each phase of work.
  - 2. HVAC system isolation schematic drawing.
  - 3. Location of proposed air-filtration system discharge.
  - 4. Waste handling procedures.
  - 5. Other dust-control measures.

#### 1.5 QUALITY ASSURANCE

- A. General: Comply with governing regulations and utility company regulations and recommendations for the construction of temporary facilities including, but not necessarily limited to, code compliances, permits, inspections, testing, health, safety, pollution and environmental compliances.
- B. Fire-safety: Comply with NFPA 421 “Standard for Safeguarding Construction, Alteration, and Demolition Operations.”
- C. Safety: Comply with ANSI/ASSE A10 “Construction Package” series of safety construction standards.
- D. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- E. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- F. Accessible Temporary Egress: Where temporary accessible egress from existing buildings or portions thereof is provided, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

#### 1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before University's acceptance, regardless of previously assigned responsibilities.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide both new or used materials and equipment for temporary facilities, which are in substantially undamaged and serviceable condition. Provide types and qualities which are recognized in the construction industry as suitable for the intended use in each application. Comply with Utility Company requirements as applicable.

### 2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
  - 1. Store combustible materials apart from building.
  - 2. Comply with Section 01 10 00 "Summary" for use of site for staging areas.

### 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. Digital Camera: Minimum 12 megapixel; available in field office for use.
- C. Thermometer: Outdoor, re-settable type indicating daily maximum and minimum temperatures.
  - 1. Locate in a shaded-from-the-sun, conveniently readable location that will give reasonably accurate readings of the actual air temperature and be reached easily for resetting.
  - 2. Maintain daily log of reading.
- D. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate, expand and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
- C. Use qualified workers for the installation of temporary facilities.

### 3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, University, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services. Comply with requirements in Section 01 10 00 "Summary" for existing utility disruption procedures.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction. Where available, connect to University's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to University. At Substantial Completion, restore these facilities to condition existing before initial use.
  - 1. Obtain and pay for all required water taps.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
  - 1. Toilets: Use of University's existing toilet facilities is not permitted.
  - 2. Provide temporary toilets within available site area in location approved by University which will best serve the needs of construction personnel.
  - 3. Supply and maintain toilet tissue, paper towels, paper cups and similar disposable materials as appropriate for each sanitary facility, and provide appropriate waste paper containers for used materials.
  - 4. At Contractor's option, provide drinking water for construction personnel by either water-system-connected drinking fountains or by containerized tap dispensers with paper cups (or both).
- E. Heating: Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
  - 1. HVAC Equipment: Unless University authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
    - a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
    - b. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
    - c. Permanent HVAC System: If University authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air and exhaust grille in system and remove at end of construction. Clean and adjust HVAC system and put in new condition before Completion as required in Section 01 77 00 "Closeout Procedures".
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
    - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
  2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
  3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. 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 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.
1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide weatherproof, grounded, electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Include, as required, transformers, overload protected disconnects, automatic ground fault interrupters and main distribution switchgear. Maintain equipment in a condition acceptable to University.
1. Install electric power service overhead unless otherwise indicated.
  2. Where available capacity exists in existing system, connect temporary service to University's existing power source, as directed by University.
  3. Provide separate connection for power and for lighting.
  4. Provide sufficient 220v outlets for special tools, welding equipment and similar devices requiring such service at locations where required.
  5. Provide sufficient circuits and duplex 120v single phase outlets so located that any part of the work can be reached with a 75 foot extension cord to accommodate normal power tools and supplemental lighting.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Provide temporary light to levels and as required by governing regulations but not less than minimum 5 foot-candle illumination in all areas accessible to workers during hours they are at the job; minimum 10 foot-candles for shop areas; 20 foot-candles or more where detailed or finishing work is being done, supplemented as may be required.
  2. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
  3. Install lighting for Project identification sign.
  4. Where permanent light fixtures have been used for temporary lighting, supply temporary lamps and replace with new lamps at time of Completion.
  5. Provide lighting in stairways and exits at all times.
- J. Telephone Service: Provide temporary telephone service in Contractor's field office and distribute to each work station.



1. Pay for line installation, monthly charges, and expenses necessary to extend service from minimum point of presence (MPOP) as determined by University I/S.
2. Provide temporary telephone service in common-use facilities for use by all construction personnel.
3. Provide answering machine and a dedicated telephone line for a facsimile machine.
4. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

### 3.3 SUPPORT FACILITIES INSTALLATION

#### A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until Architect/Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to University.

#### B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Surface temporary access road with road base material of not less than 4 inch thickness and compact.
2. Provide temporary signage and temporary pedestrian accessways or other special considerations necessary for continued University operations.
3. Provide stop sign(s) at all points of egress from construction site to meet standards established in the Manual of Uniform Traffic Code Devices (MUTCD).
4. Maintain University access to areas affected by temporary access roads during inclement weather.
5. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
6. Restore to original condition to satisfaction of University when no longer required.

#### C. Temporary Walks: Construct and maintain temporary walks around the construction work and to offices, toilets and similar locations on the site.

#### D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

#### E. Parking: Comply with requirements in Section 01 10 00 "Summary."

#### F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

#### G. Project Signs: Provide Project signs at locations indicated or directed. Unauthorized signs are not permitted.

1. Identification Signs: Unless otherwise indicated, provide 4 foot by 8 foot Project identification sign.
    - a. Architect/Engineer will provide sign layout, including colors and graphics as approved by University Resident Architect through University Project Manager.
  2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  3. Engage an experience sign painter to apply required colors and graphics in a neat and professional manner.
  4. Maintain and touchup signs so they are legible at all times.
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 73 00 "Execution."
1. Coordinate with University Project Manager to obtain approval from University Environmental Services Manager.
  2. Provide waste chutes as required in accordance with applicable laws and regulations.
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel. The selection of type, size and number of hoisting facilities is the solely the responsibility of the Contractor.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Elevator Use: Use of elevators is not permitted without prior written approval of the Architect/Engineer and University Project Manager.
1. If so approved, only one designated elevator may be used subject to the requirements of "Existing Elevator Use" paragraph below.
- K. Existing Elevator Use: When approved by University, one designated existing elevator may be used at no charge to Contractor or other subcontractors for transporting personnel, small tools, materials, and equipment. Comply with requirements of Section 01 10 00 "Summary" and the following:
1. Contractor will not be granted exclusive use of the designated elevator. University personnel and staff will be permitted to use this elevator as their work duties require.
  2. Entire car is lined (floor, walls, ceiling) with 3/4 inch Fir plywood or equivalent.
  3. Total load carried does not exceed rated capacity of elevator.
  4. No materials, equipment, trash, tools or other items too large to be readily moved into and out of the car may be carried in the elevator.
  5. Before acceptance of the building, linings are removed; all exposed surfaces are in new condition; all controls, relays, other parts showing any wear have been replaced.
  6. Entire elevator, including machinery, electrical components, doors, operators and controls shall be tested, adjusted, and put in new condition with specified warranties and maintenance to take effect at date of Completion Certificate.
  7. Written clearance has been obtained from the Elevator Service Company stating that the installation is safe and complete for this use prior to using it.
  8. The Contractor signs the Elevator Service Company's standard agreement and release forms for this usage and pays charges for maintenance, service, repairs, and reconditioning.

- L. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- M. Existing Stair Usage: Use of University's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to University. 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 stairs become damaged, restore damaged areas so no evidence remains of correction work.
- N. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

### 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Protection of Work: Protect in-progress and completed work from damage or deterioration, other than normal weathering of exposed materials, through construction duration until completion, as appropriate and as recommended by manufacturer and Installer.
  - 1. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects, and storage.
  - 2. Prohibit traffic and storage on waterproofed and roofed surfaces, on lawn and landscaped areas.
  - 3. Always protect excavation, trenches, and building, from damage from rain water, spring water, ground water, backing up of drains or sewers. Provide pumps, equipment, enclosures, to provide this protection.
  - 4. Remove protective coverings and materials at the appropriate time but no later than final cleaning operations.
- C. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
  - 1. Comply with work restrictions specified in Section 01 10 00 "Summary."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
  - 1. Comply with Section 01 41 00 "Regulatory Requirements" Article "MS4 Storm Water and Water Quality Permits."
  - 2. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
  - 3. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  - 4. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
  - 5. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

- E. Stormwater Control: Comply with Section 01 41 00 “Regulatory Requirements” Article “MS4 Storm Water and Water Quality Permits.”
- F. Tree and Plant Protection: Install temporary fencing or guard located outside the drip line of trees to protect vegetation from damage arising out of construction operations, including cutting, breaking or skinning of roots and skinning or bruising of bark. Protect tree root systems from damage, flooding, and erosion.
  - 1. Do not stockpile construction materials or excavated materials inside dripline.
  - 2. University will identify historically recorded trees and vegetation not to be disturbed.
  - 3. Water trees and other vegetation to remain as required to maintain their health for the duration of the Project.
  - 4. Repair or replace trees and vegetation damaged by construction operations in a manner acceptable to Architect/Engineer. Use a qualified tree surgeon to perform the work.
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- H. Site Enclosure Fence: Within 10 business days of mobilization, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates and will protect adjacent sites from damage or contamination..
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide bases for supporting posts.
  - 3. Locate so base supports do not extend outside work area where adjacent to walkways.
  - 4. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to University.
- I. Security: Provide security program and facilities to protect the Work, existing facilities, and University operations and to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
  - 1. Coordinate with University Police.
  - 2. Provide lockable entrances and lock entrances at end of each work day.
  - 3. After review and approval by University, install temporary enclosure around partially completed areas of construction.
  - 4. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting wherever required to prevent accidents and losses.
- K. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- L. Covered Walkway: Where regulations require or where a public roadway/walkway adjoins the Project site and materials may be hoisted across the walkway, erect protective, covered walkway for passage of

individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing.
  2. Provide overhead waterproof decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
  3. Paint and maintain appearance of walkway for duration of the Work in a manner acceptable to the Architect/Engineer and University.
  4. Extend back wall beyond structure to complete the enclosure fence.
- M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
  2. Coordinate temporary enclosures with ventilating and drying-of-the-work requirements, so as to avoid dangerous conditions and deleterious effects.
  3. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.
- N. Temporary Partitions: Provide floor-to-floor or floor-to-ceiling dustproof partitions terminating in dustproof floor or ceiling above to limit dust and dirt migration and to separate existing active elevator hoistways and other areas occupied by University from dust, fumes and noise in compliance with Section 01 35 46 "Indoor Air Quality" and the following:
1. Construct dustproof partitions with 5/8 inch gypsum wallboard with joints taped on occupied side, and 1/2 inch fire-retardant-treated plywood on construction operations side.
  2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
  3. Insulate partitions to control noise transmission to occupied areas.
  4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
  5. Protect air-handling equipment.
  6. Provide walk-off mats at each entrance through temporary partition.
  7. At elevator hoistway entrances not used during construction, seal openings with plastic sheet and duct tape.
- O. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Fire Extinguishers: Minimum one per floor at or near useable exit.
    - a. Provide additional extinguishers where convenient and effective for intended purpose.
    - b. Comply with NFPA 10 to the extent applicable.
  2. Strictly enforce site prohibition against smoking.
  3. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  4. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Coordinate with University Project Manager to review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

5. 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.
6. Maintain unobstructed access to fire extinguishers, temporary fire protection facilities, stairways and other access routes for fighting fires.
7. Store combustible materials in containers in fire-safe locations.
8. Permanent Fire Protection System: Complete and make operational at earliest possible date. Instruct site personnel on use of permanent system.

### 3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Comply with requirements in Section 01 35 46 "Indoor Air Quality Procedures."

### 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.
  1. Do not permit temporary offices and similar temporary or permanent spaces to be used as living quarters or for other unintended occupancies or uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
  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.
- C. Janitorial Services: Provide daily janitorial services for temporary offices, toilets, and similar areas at the project site. Require users of other temporary facilities to maintain clean and orderly premises.
- D. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
- E. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- F. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion, unless Architect/Engineer requests that it be retained for a longer period of time. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  1. Materials and facilities that constitute temporary facilities are property of Contractor. University reserves right to take possession of Project identification signs.
  2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

**END OF SECTION 01 50 00**



## SECTION 01 60 00

### 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. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 01 21 00 "Allowances" for products selected under an allowance, if applicable.
  - 2. Section 01 23 00 "Alternates" for products selected under an alternate, if applicable.
  - 3. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
  - 4. Section 01 42 00 "References" for applicable industry standards for products specified.
  - 5. Section 01 77 00 "Closeout Procedures" for submittal of project warranties.

##### 1.3 DEFINITIONS

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



#### 1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Requests for consideration of comparable products will only be entertained during bidding.
  - 2. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
  - 3. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation of a comparable product request. Architect/Engineer will notify Contractor of approval or rejection of proposed comparable product.
    - a. Form of Approval: Written Addendum.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

#### 1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options. The complete compatibility between the various choices available to the Contractor is not assured by the various requirements of the Contract Documents, but must be provided by the Contractor.
- B. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source.
- C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturers or producer's nameplates or trademarks on exposed surfaces of products which will be exposed to view in occupied spaces or on the exterior.
- D. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.
- E. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface which is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data.
  - 1. Name of product and manufacturer.
  - 2. Model and serial number.
  - 3. Capacity.
  - 4. Speed.
  - 5. Ratings.
  - 6. Power characteristics (if applicable).
  - 7. UL label or compliance (if applicable).

#### 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

## 1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents. Such disclaimers and limitations do not relieve warranty requirements on Work that incorporates product nor do they relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to University.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for University.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time and Form: Comply with requirements in Section 01 77 00 "Closeout Procedures."

D. Warranty Requirements:

1. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
2. 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.
3. 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 Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the University has benefited from use of the Work through a portion of its anticipated useful service life.
4. University's Recourse:
  - a. Written warranties made to the University are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the University can enforce such other duties, obligations, rights, or remedies.
  - b. Rejection of Warranties: The University reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
  - c. The University reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged, are asbestos free, and, unless otherwise indicated, are new at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. University reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product and provide only products previously approved during bid phase by written Addendum. The determination of equivalence is at the sole discretion of the Architect/Engineer who has no obligation to prove non-equivalence.
  7. Mechanical and electrical equipment design and their space requirements are based on the first named item of the Section in which specified or that scheduled on the Drawings. If other than the first named or scheduled item listed for use is selected, modification to other elements of Work may be required. Show all such modification on shop drawings and submittals as appropriate. The cost of such modifications is solely the responsibility of the Contractor.

8. Where manufacturers are listed as acceptable for specific proprietary products but precise identification by model, series, or trade name is not specified, submit detailed product information for such products for Architect/Engineer's acceptance prior to ordering. Include specific requirements for modifications to other construction, including but not limited to, power and utility requirements, characteristics, capacities, size and locations. The cost of such modifications is solely the responsibility of the Contractor.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:
  - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
4. Manufacturers:
  - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. If proposing a comparable product by another manufacturer, whether named or not, provide a custom product if manufacturer's standard product does not include salient features of the Basis-of-Design product indicated. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
6. Contractor's Option: Where materials, products, systems or methods are specified to be selected from a list of options, subject to compliance with requirements, the choice of which material, method, product or system will be solely at the Contractor's discretions. There will be no change in Contract Sum or Time because of such choice.

C. Visual Matching Specification: Where Specifications require "match Architect/Engineer's sample", provide a product that complies with requirements and matches Architect/Engineer's sample. Architect/Engineer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect/Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect/Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Prior to bid, Architect/Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer will reject request:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 60 00**

## SECTION 01 73 00

### EXECUTION

#### 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 general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. Installation of the Work.
  - 4. Cutting and patching.
  - 5. Coordination of University-installed products.
  - 6. Progress cleaning.
  - 7. Starting and adjusting.
  - 8. Protection of installed construction.
  - 9. Correction of the Work.
- B. Related Requirements:
  - 1. Section 01 10 00 "Summary" for limits on use of Project site and procedures related to utility interruptions.

##### 1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor or professional engineer.
- B. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan and Request: Submit plan and request describing procedures at least 21 calendar days prior to the time cutting and patching will be performed.
  - 1. Submit request whenever cutting and patching operation affect:

- a. Work of the University or any separate contractor.
  - b. Structural value or integrity of any element of the Project.
  - c. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
  - d. Efficiency, operational life, maintenance or safety of operational elements.
  - e. Visual qualities of sight-exposed elements.
  - f. Cutting new openings in existing structural concrete walls, floors and suspended slabs.
  - g. Cutting new openings in existing roofs and roofing materials.
  - h. Cutting exterior walls.
  - i. Cutting into shafts.
2. Include the following information:
- a. Extent: Describe reason for and extent of each occurrence of cutting and patching, including explanation of why cutting and patching operation cannot be reasonable avoided.
  - b. Changes to In-Place Construction: Describe cutting and patching methods and anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
  - c. Products: List products to be used for patching and firms or entities that will perform patching work.
  - d. Trades: Indicate trades and subcontractors who will perform the work.
  - e. Dates: Indicate when cutting and patching will be performed.
  - f. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
    - 1) Include description of provisions for temporary services and systems during interruption of permanent services and systems.
    - 2) Comply with requirements of Section 01 10 00 "Summary" related to existing utility and system interruptions.
  - g. Structural Elements: Where cutting and patching structural elements requires the addition of reinforcement, submit details and calculations signed and sealed by an Engineer registered in the State of Colorado. Indicate how new reinforcing will be integrated with original structure.
3. Limitations: Approval of cutting and patching request does not waive right of Architect/Engineer or University to later require complete removal and replacement of work found to be unsatisfactorily cut and patched.
- D. Certified Surveys: Submit two copies signed by land surveyor or professional engineer.
- E. Final Property Survey: Submit one electronic and two paper copies showing the Work performed and record survey data.
1. Include certified statement that lines and levels of the work comply with the requirements of the Contract Documents and listing authorized or accepted deviations, cross-referenced to Change Order number, where applicable.

## 1.5 QUALITY ASSURANCE

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

- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, notify Architect/Engineer of locations and details of cutting and await directions from Architect/Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
  2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include but are not limited to the following:
    - a. Primary operational systems and equipment.
    - b. Fire separation assemblies.
    - c. Air or smoke barriers.
    - d. Fire-suppression systems.
    - e. Mechanical systems piping and ducts.
    - f. Control systems.
    - g. Communication systems.
    - h. Fire-detection and -alarm systems.
    - i. Conveying systems.
    - j. Electrical wiring systems.
    - k. Operating systems of special construction.
  3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
    - a. Water, moisture, or vapor barriers.
    - b. Membranes and flashings.
    - c. Exterior curtain-wall construction.
    - d. Sprayed fire-resistive material.
    - e. Equipment supports.
    - f. Piping, ductwork, vessels, and equipment.
    - g. Noise- and vibration-control elements and systems.
  4. Visual Elements: Do not cut and patch construction exposed to the exterior or exposed in occupied spaces in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect/Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
  5. Hazardous Materials: Do not proceed with cutting and patching operations until University has examined existing construction for the presence of asbestos and/or lead-based coatings. Comply with requirements in Section 01 35 00 "Special Procedures."
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.



## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
  - 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Division 01 Section "Sustainable Design Requirements."
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect/Engineer for the visual and functional performance of in-place materials.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
  - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work. Notify University Project Manager and Architect/Engineer and obtain approval prior to disturbing, moving or penetrating soil.
  - 1. Arrange for locating buried utilities including water and sewer lines within construction limits. Obtain location information and stake all known utilities prior to commencing construction activities.
    - a. Contact Utility Notification Center of Colorado (UNCC), 1-800-922-1987, and comply with UNCC guidelines.
  - 2. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
  - 3. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present, for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility or University, as appropriate, that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect/Engineer according to requirements in Section 01 31 00 "Project Management and Coordination."

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect/Engineer promptly.
- B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
  1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  2. Establish limits on use of Project site.
  3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  4. Inform installers of lines and levels to which they must comply.
  5. Check the location, level and plumb, of every major element as the Work progresses.
  6. Notify Architect/Engineer when deviations from required lines and levels exceed allowable tolerances. Record deviation which are accepted (i.e., not corrected) on record drawings in accordance with the requirements of Section 01 78 39 "Project Record Documents."
  7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

- D. **Building Lines and Levels:** Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. **Record Log:** Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect/Engineer.

### 3.4 FIELD ENGINEERING

- A. **Identification:** University will identify existing benchmarks, control points, and property corners.
- B. **Reference Points:** Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
  - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect/Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect/Engineer before proceeding.
  - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. **Benchmarks:** Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. **Certified Survey:** On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. **Final Property Survey:** Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
  - 2. **Recording:** At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated to the extent they are more explicit or stringent than requirements of the Contract Documents.
- C. Install products at the time and under conditions, including weather that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Isolate each part of complete installation from incompatible material as needed to prevent deterioration.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- H. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- I. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned, true and level as applicable, with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect/Engineer.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- J. Attachment to Concrete:
  - 1. No drilled inserts or powder-actuated fasteners are permitted in pre-stressed concrete except as specifically authorized by Contractor and carried out under the direct supervision of its Superintendent.
  - 2. Only those devices with a maximum controlled penetration of 3/4 inch or less will be permitted. Make holes through slabs by means of sleeves placed no closer than 2 inch from tensioning cables. Core drilling will not be permitted unless unavoidable and as specified for cutting and patching in this Section.

- K. Joints: Unless indicated otherwise, make joints of uniform width. Where joint locations in exposed work are required but not indicated, arrange joints for the best visual effect. Confirm arrangement with Architect/Engineer before proceeding. Fit exposed connections together to form hairline joints.
- L. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Responsibility: Provide cutting and patching work, including attendant excavation and backfill required to complete the Work or to:
  - 1. Make components fit together properly.
  - 2. Uncover portions of the Work to provide for installation of ill-timed work.
  - 3. Remove and replace defective work or work not conforming to requirements of Contract Documents.
  - 4. Remove samples of installed work as specified for testing.
  - 5. Provide routine penetrations of non-structural surfaces for installation of piping and electrical conduit.
- C. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- D. Temporary Support: Provide temporary support of work to be cut.
- E. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- F. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."
- G. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."
- H. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations. Employ methods which will prevent settlement or damage to other work.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- I. 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 practicable. Provide materials and comply with installation requirements, including tolerance, specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- J. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.
- ### 3.7 UNIVERSITY-INSTALLED PRODUCTS
- A. Site Access: Provide access to Project site for University's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by University's construction personnel.
1. Construction Schedule: Inform University of Contractor's preferred construction schedule for University's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify University if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include University's construction personnel at preinstallation conferences covering portions of the Work that are to receive University's work. Attend preinstallation conferences conducted by University's construction personnel if portions of the Work depend on University's construction.

### 3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven calendar days during normal weather or three calendar days if the temperature is expected to rise above 80 deg F.
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
- B. Collection Point: Review location with University and obtain approval.
- C. Site: Maintain Project site free of waste materials and debris.
- D. Wind Blown Debris: Prevent spread of trash, debris, cartons, packing material, or other waste on or off Project site by wind.
- E. Dust: Sprinkle dusty debris with water.
- F. Packing Materials: Immediately after uncrating or unpacking materials or equipment, remove all crating, lumber, excelsior, wrapping or other like combustible materials from building to central collection facility.
- G. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- H. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- I. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- J. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- K. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

- L. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- M. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- N. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- O. Snow and Ice: Remove snow and ice from sidewalks adjacent to site and from access ways to building and construction site.
- P. Streets: At frequency required by University and/or governing authority, clean adjacent and nearby streets of dirt resulting from construction operations.

### 3.9 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- 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: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

### 3.10 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.
- C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures 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. Air contamination or pollution.
  - 7. Water or ice.
  - 8. Solvents.
  - 9. Chemicals.



10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Misalignment.
25. Excessive weathering.
26. Unprotected storage.
27. Improper shipping or handling.
28. Theft.
29. Vandalism.

**END OF SECTION 01 73 00**

## **SECTION 01 73 05**

### **UTILITY INTERRUPTION – MECHANICAL, ELECTRICAL, PLUMBING**

#### **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 governing the shutdown of mechanical, electrical, and plumbing services for proper notification of all impacted by shutdown.
- B. Contractor to complete attached outage request and submit to university project manager.
- C. Outage requests must be submitted in advance per the time periods identified on attached form.

#### **PART 2 - PRODUCTS (Not Used)**

#### **PART 3 - EXECUTION**

##### **3.1 COORDINATION**

- A. University staff will coordinate and announce internally to all impacted areas.
- B. Contractor & Subcontractors requesting outages must be present at specified time identified in approved outage request to initiate the start of outage. If contractors are not present, outage may be postponed.
- C. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

**END OF SECTION 01 73 05**



## Facilities Management

### **UTILITY INTERRUPTION/ SHUTDOWN REQUEST FORM** **INSTRUCTIONS**

1. Starting on page 2, fill out all necessary information on the Utility Interruption/ Shutdown Request Form.
2. On page 3, fill out all necessary information on the Utility Interruption/ Shutdown Method of Procedure.
3. Utility Interruption/ Shutdown Request Forms can only be submitted to the Outage Coordinator by a University Representative. All others will be returned to sender.
4. Contractors submit your request to your University Project Manager, not the contracts listed below.
  - a. Submit the Utility Interruption/ Shutdown Request Form and the Utility Interruption/ Shutdown Method of Procedure to:  
[Jesse.Walklett@CUAnschutz.edu](mailto:Jesse.Walklett@CUAnschutz.edu)  
Cc...  
[David.Tilton@CUAnschutz.edu](mailto:David.Tilton@CUAnschutz.edu)  
[Ron.Turner@CUAnschutz.edu](mailto:Ron.Turner@CUAnschutz.edu)
5. Requests for minor outages (**determined by severity of impact**) must be submitted to the Outage Coordinator seven (7) working days prior to the requested start date.
6. Requests for major outages (**determined by severity of impact**) must be submitted to the Outage Coordinator thirty (30) working days prior to the scheduled outage.
7. After receiving both the Utility Interruption/ Shutdown Request Form and the Utility Interruption/ Shutdown Method of Procedure, the Outage Coordinator will create an outage file and begin coordinating the request.
8. After the outage has been successfully coordinated, the request will be submitted for approval.
9. After the outage has been approved, the Outage Coordinator will send out the approved outage notice, create a meeting reminder for Facilities Staff, and send out the MOP followed by a Campus Announcement.

When an Outage is requested without the benefit of the minimum advance notice (7 days for a minor outage - 30 days for a major outage), **the Outage Coordinator will request that the Project Manager and Contractor still submit an adequate Method of Procedure (MOP) for the outage.** The requester will be responsible for distributing notices to the occupants of any and all affected area(s). The requester will also distribute a copy of the Outage Posting and a copy of the MOP to the Contractor and/or person performing the outage. The requester will then send, via email, the names of all the people they have distributed notices to, as confirmation to the Outage Coordinator.  
**ANY AND ALL DISPUTES WITH THE OCCUPANTS OF THE AFFECTED AREA(S) WILL BE RESOLVED BY THE REQUESTER.**

**In case of an EMERGENCY, contact the CSC at 303-724-1777**



Facilities Management

**UTILITY INTERRUPTION/ SHUTDOWN REQUEST FORM**

<b>Utility or Service Requesting to be Interrupted or Shutdown</b>	
<b>Affected Areas (Building &amp; Room Numbers)</b>	
<b>Outage Requester (Name &amp; Phone Number)</b>	
<b>Requested Start Time &amp; Start Date</b>	<b>Time:</b> _____ <b>Date:</b> _____
<b>Anticipated Finish Time &amp; Finish Date</b>	<b>Time:</b> _____ <b>Date:</b> _____
<b>University Project Manager (Name &amp; Phone Number)</b>	
<b>University Back-Up Project Manager (Name &amp; Phone Number)</b>	
<b>Contractor (Name &amp; Phone Number)</b>	
<b>Sub-Contractor (Name &amp; Phone Number)</b>	
<b>Facilities Management Building Representative (Name &amp; Phone Number)</b>	
<b>Maximo Work Order Number or Project Number</b>	
<b>Additional Assistance Required? (Check All Required) *Facilities Maintenance Use Only*</b>	Zone Staff ___ Electrical Staff ___ Plumbing Staff ___ HVAC Staff ___ Shift Staff ___ Other ___ (Who?) _____

Completely fill out the Method of Procedure section on page 3.

A missing or incomplete MOP will result in an automatic denial of the outage request.



University of Colorado  
Anschutz Medical Campus

## Facilities Management

### **UTILITY INTERRUPTION/ SHUTDOWN METHOD OF PROCEDURE**

Clearly list all necessary actions in a step-by-step format that will be required for completion of this request.

Additional Notes:



## SECTION 01 77 00

### CLOSEOUT PROCEDURES

#### 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 contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures, including Notice of Completion and Final Inspection procedures.
  - 2. Occupancy procedures, including Notice of Approval of Occupancy/Use and University Supplemental Notice of Occupancy and Use List.
  - 3. Final Acceptance procedures, including Pre-Acceptance Checklist and University Supplemental Building/Project Acceptance List.
  - 4. Inspections after completion.
  - 5. Warranties.
  - 6. Final cleaning.
  - 7. Repair of the Work.
- B. Related Requirements:
  - 1. Section 01 32 33 "Photographic Documentation" for submitting final completion construction photographic documentation.
  - 2. Section 01 73 00 "Execution" for progress cleaning of Project site.
  - 3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
  - 4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 5. Section 01 79 00 "Demonstration and Training" for requirements for instructing University's personnel.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Notice of Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Acceptance.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.



- C. Field Report: For pest control inspection.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

#### 1.6 NOTICE OF COMPLETION AND SUBSTANTIAL COMPLETION PROCEDURES

- A. Procedures and Submittals Prior to Notice of Completion: Complete and submit all of the following items prior to submitting Notice of Completion to Architect/Engineer. Include Contractor's comprehensive list of items to be completed, corrected or not in compliance with the Drawings and Specifications.
  - 1. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's preliminary punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
  - 2. Building Inspection Record: Submit completed record with all required corrections noted.
  - 3. Certificate of Occupancy: Submit Certificate of Occupancy (CO) or Temporary Certificate of Occupancy (TCO).
  - 4. Final Completion Schedule: Submit schedule for performing and completing all work indicated on the Contractor' list of incomplete items.
  - 5. Submit sustainable design documentation.
  - 6. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
  - 7. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 8. Submit test/adjust/balance records.
- B. Final Inspection: Submit Notice of Completion to Architect/Engineer. Upon receipt, Architect/Engineer and University will review and if all items on the University Supplemental Notice of Completion Checklist are complete will, within the timeframe required by the Contract, schedule and make an inspection of the Project to determine whether the Work is substantially complete.
  - 1. Final Punch List: Based on the inspection, Architect/Engineer will prepare a final punch list of work to be completed, work not in compliance with the Drawings or Specifications, and unsatisfactory work for any reason.
  - 2. Re-inspection: If the cumulative number of items identified on the final punch list prevents a determination that the work is substantially complete, complete those items and when complete resubmit Notice of Completion. Upon receipt of resubmittal, Architect/Engineer and University will then schedule and make a re-inspection of the Project to determine whether the Work is substantially complete.
- C. Notice of Substantial Completion: When inspection of the Work indicates that the Project is substantially complete and all other Contract provisions required for substantial completion have been satisfied, Architect/Engineer will issue a Notice of Substantial Completion (State Form SBP-07).

#### 1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor or as approved by Architect/Engineer.
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Architect/Engineer.
    - d. Name of Contractor.
    - e. Page number.
  4. Submit list of incomplete items in the following format:
    - a. MS Excel and PDF electronic file. Architect/Engineer will return annotated file.

#### 1.8 OCCUPANCY PROCEDURES

- A. Procedures and Submittals Prior to Occupancy: Complete and submit all items on both State Form SBP-01 "Notice of Approval of Occupancy/Use" and University Supplemental Notice of Occupancy and Use List.

#### 1.9 FINAL ACCEPTANCE PROCEDURES

- A. Procedures and Submittals Prior to Final Acceptance: Complete and submit all items on both State Form SBP-05 "Pre-Acceptance Checklist" and University Supplemental Building/Project Acceptance List.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 business days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.10 SETTLEMENT AND FINAL PAYMENT

- A. Submit and complete all of the following as a condition precedent to settlement and final payment:
1. All guarantees and warranties.
  2. All statement to support local sales tax refunds, if any.
  3. Three (3) sets of operation and maintenance manuals.
  4. One (1) set of as-built Contract Documents showing all job changes.
  5. All demonstration and training completed in accordance with Section 01 79 00.

6. All punch list items documented as complete.

B. Final Certificate of Payment: Submit in accordance with the requirements of Section 01 29 00 "Payment Procedures."

#### 1.11 INSPECTIONS AFTER COMPLETION

A. Warranty/Guarantee Inspections: During the warranty period, accompany Architect/Engineer and University Representative, and participate in inspection(s) of the Project to identify defective and deficient work at intervals and as required by the Contract.

B. List of Deficient or Defective Work: Within 10 business days of inspection, Architect/Engineer will provide Contractor with a list of items requiring correction.

C. Remedial Work: Upon receive of itemized list, immediately correct and remedy deficiencies and defects in a manner satisfactory to the Architect/Engineer and University.

#### 1.12 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties to the Architect/Engineer prior to advertisement of the Notice of Contractor's Settlement. If the Notice of Acceptance designates a commencement date for warranties other than the date of Notice of Acceptance for the Work, or a designated portion of the Work, submit written warranties upon request of the Architect.

B. Partial Occupancy: When a designated portion of the Work is completed and occupied or used by the University, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Architect/Engineer within fifteen (15) calendar days of completion of that designated portion of the Work.

C. Special Warranties: When a special warranty is required to be executed by the Contractor, or the Contractor and a Subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the University through the Architect/Engineer for approval prior to final execution. Refer to individual Specification Sections for specific requirements for special warranties.

D. Form of Submittal: Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Number of Copies: Two.

2. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

3. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

4. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

5. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

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

- F. List of Extended Warranties: Provide a comprehensive list of all manufacturers' standard and special warranties with duration greater than one year after Notice of Acceptance. Organize list into an orderly sequence based on table of contents of the Project Manual.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
  - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.
  - 2. Do not use sweeping compounds on concrete floors that will leave residue affecting finish floor materials.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations immediately prior to Occupancy for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior finishes to a dirt-free condition, free of grease, dust, stains, films, fingerprints, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - j. Power scrub and power buff resilient flooring surfaces, tile and fluid-applied flooring.
    - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

- l. Remove labels that are not permanent.
  - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment where applicable, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
    - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
  - q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
  - r. Clean food service equipment to sanitary condition acceptable for intended food service use and approved by authority having jurisdiction.
  - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

### 3.3 ATTACHMENTS

- A. Samples of the following forms are appended to this Section for reference following End of Section 01 77 00:
  1. University of Colorado Denver | Anschutz Medical Campus Supplemental Notice of Occupancy and Use List.

2. University of Colorado Denver | Anschutz Medical Campus Supplemental Building / Project Acceptance List.

**END OF SECTION 01 77 00**



## Supplemental Notice of Occupancy and Use List

Project Name & Number: \_\_\_\_\_

Contractor: \_\_\_\_\_

In addition to completing Notice of Approval of Occupancy / Use (SBP-01), the following items must be completed before Occupancy is approved.

Activity	Date Completed	Remarks
1. Final and formal address posted on the building entries.		
2. A copy of the Contractor's in-progress red line "as-built" drawings has been given to BMO representative & a 2 <sup>nd</sup> copy is provided-for Projects plan room. This is to include landscape drawings showing irrigation installation.		
3. Maintenance, operations and spare parts manuals on all installed equipment.		
4. Notice of Partial Substantial Completion concerning roles/ responsibilities of University and Contractor for security, maintenance, heat, utilities reviewed and accepted.		
5. Manufacturer maintenance, operations and spare parts manuals for fixtures, mechanical, electrical and plumbing.		
6. Hardware-maintenance, operations and spare parts manuals for doors & locks, including roll up doors.		
7. Warranty Dates and Contact list for all Contractors and Suppliers given to BMO.		
8. Transfer utility account from Contractor to Facilities Operations.		
9. Site plan to include first floor main isolation locations and plans for each floor to include main utility shutoffs, for utilities to include water, electrical, steam, sewer, fuel supply, telecom, fiber optic and gasses, identified on a set of drawings.		
10. If Commissioning Report is completed, BMO has reviewed/ commented, including electrical, plumbing, mechanical/ HVAC.		
11. All Contractor provided equipment has new filters & construction filters removed.		
12. Not Used		
13. Elevator equipment rooms insulated and space conditioned for control system requirements.		
14. Testing Certifications provided to BMO for Elevators, Fire Systems & Annunciator Systems.		
15. FSS has been provided with copy of Building Department testing and inspection report for window washing equipment.		
16. Roof walking pads to access equipment are installed.		
17. PM to communicate to fire department via Life Safety Officer that building has transitioned to BMO. Alarms at Anschutz Medical Campus report to University Police Dispatch and at Downtown report to designated monitoring company.		



18. BAS System (Siemens), Energy and Lighting, Fuel Systems, and Power Management must report remotely & verify with University - Engineering.		
19. Training for BMO and FSS on installed equipment and systems is completed.		
20. Equipment keys and locks transitioned to Operations, including fire panels, electrical panels, directories and generator panels. Construction cores removed and replaced with permanent cores.		
21. Access control pathways and junction boxes for installed doors, gates, loading docks and roof access complete. <b><u>*All wiring and hardware completed and electronic security access controls in place and tested by University Electronic Security.</u></b>		
22. EH&S is provided, as applicable for project, with fume hood certification, water testing certification, hazardous waste compliance certification, radiation compliance certification, BSL3 certification, and all other specialty equipment certification.		
23. PM notifies University Risk Management that project is transferring to University and notifies Contractor that it can eliminate Builders Risk Insurance.		
24. Not Used		
25. Not Used		
26. Elevator tools, including hand tools, computer, proprietary and operational software is received and confirm 1-year service from date of acceptance.		
27. All computers and software required in drawings and specs. are received, including for BAS, Energy and Lighting, Fuel Systems, and Power Management, and any specialty software and alarm codes for operating systems.		
28. For all areas to be transferred to University, all waste and debris removed; floor and wall surfaces clean and in good repair; ceiling surfaces clean, unmarked, in place; site, including sidewalks, cleared of debris and construction equipment; and roof is clear of all materials and debris.		
29. Water chlorination and testing complete and provided by PM to Chief Building Official and BMO via BMO Rep.		
30. Toilet accessories are in place that meet custodial contract.		
31. Trash receptacles outside the building are in place		

\_\_\_\_\_  
University Project Manager  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University BMO Rep.  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University FSS Rep  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University Downtown Rep. (If Necessary)  
(sign & print name)

\_\_\_\_\_  
Date

**\*Highlighted items are not the responsibility of Contractor but PM and BMO Rep must ensure these are completed and operational prior to occupancy and use.**

Mark N/A by item if it is not applicable to project

3.1.12

## Supplemental Building / Project Acceptance List

Project Name & Number: \_\_\_\_\_

Contractor: \_\_\_\_\_

In addition to completing Pre-Acceptance Checklist (SBP-05), the following items must be completed before Final Acceptance.

Activity	Date Completed	Remarks
1. Review State Buildings Pre-Acceptance check list & Notice of Approval of Occupancy / use form with BMO rep & confirm agreement with status		
*2. Establish list of post construction change orders & track separately from basic project until items are complete – call it Phase 2 to avoid delay on basic project		
3. O & M Manuals given to BMO Representative and BMO Archivist (2 hard copies and 1 electronic total)		
*4. Record Documents – a hard copy of plans and specifications are provided for plan room & given to BMO & electronic auto cad & specs are given to Archive Officer (Art Steinman) this is to include landscape drawings showing irrigation installation.  Fire Alarm and suppression system shall have record drawings produced by the contractor and shall include PDFs and native graphic files, and CAD files include graphics maps and Fireworks graphics.		
*5. Final Site Walk is completed with University Grounds Supervisor. Drain barriers are removed and storm drains cleared. MS4 storm water plan, CDPHE permits, and evidence of final closeout received by Project Manager and all copied to University Engineering Division.		
*/**6. <b><u>Move-related work items complete including physical move, tours (occupants &amp; police), mail, phone &amp; electrical hook ups for equipment &amp; furniture systems complete &amp; freezers enrolled in University freezer program.</u></b>		
7. If exterior work is applicable: Landscape – Include a walk through with University Grounds for 1) new & established 1-year service date; 2) existing damaged landscape is repaired; and 3) irrigation – zone control test is complete.		
8. Attic stock, matches spec. requirements, is located in secured location, and is inventoried.		
9. Electrical system one line diagram framed and mounted in electrical room.		
10. Spare fire suppression heads in cabinets and tool: cabinet in main electrical room includes one complete set of spare fuses for major equipment.		
11. Contractor keys issued by University BMO returned to University Key Shop via PM/ BMO Rep.		
12. Interior Finishes Binder given to the University Project Manager: (Two hard copies)		

13. Not Used		
14. Not Used		
15. Safety grating in pipe chases in place.		
16. Signs in place including monument sign, building exterior and site signage and building interior signage.		
17. All applicable reports, including Air Emission reports; Sewer Reports, including for process diverters, traps and collection tanks; Fuel Storage Tank and Detection reports; and Water System tests and reports provided to BMO via PM and BMO Rep.		
18. Not Used		
19. Not Used		
20. Not Used		
21. Not Used		
22. If commissioning is included for project, Commissioning Agent certification is received by BMO via PM and BMO Rep.		

\_\_\_\_\_  
University Project Manager  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University BMO Rep.  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University FSS  
(sign & print name)

\_\_\_\_\_  
Date

\_\_\_\_\_  
University Downtown Rep (if necessary)  
(sign & print name)

\_\_\_\_\_  
Date

\*Warranty dates are not subject to completion of these items by contract

**\*\* Highlighted items are not the responsibility of Contractor but PM and BMO Rep must ensure these are completed and operational prior to occupancy and use.**

Mark N/A by item if it is not applicable to project

3.1.12

## SECTION 01 78 23

### OPERATION AND MAINTENANCE DATA

#### 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 preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Systems, subsystems, and equipment operation and maintenance manuals.
  - 3. Product maintenance manuals.
  - 4. Emergency manuals.
  - 5. Framed operating and maintenance instructions.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Section 01 91 13 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

##### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Schedule: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 30 calendar days before commencing demonstration and training. Architect/Engineer will return copy with comments.
  - 1. Correct or revise each manual to comply with Architect/Engineer's comments. Submit copies of each corrected manual within 15 calendar days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.
- B. Format: Submit operations and maintenance manuals in the following format:
  - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect/Engineer.

- a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
  - b. Compile entirely from documents with searchable text.
  - c. Enable inserted reviewer comments on draft submittals.
2. Paper copies. Assemble in accordance with the requirements of this Section.
- a. Submit three final copies, one to be retained by the Architect/Engineer and two to be retained by the University.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 30 calendar days before commencing demonstration and training. Architect/Engineer will return copy with comments.
1. Correct or revise each manual to comply with Architect/Engineer's comments. Submit copies of each corrected manual within 15 calendar days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.

## PART 2 - PRODUCTS

### 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
1. List of documents.
  2. List of systems.
  3. List of equipment.
  4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

### 2.2 GENERAL REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Intent: Prepare data in form of an instructional manual for use by University personnel.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
  2. Table of contents.
  3. Manual contents.
- C. Title Page: Include the following information:
1. Subject matter included in manual.
  2. Name and address of Project.
  3. Name and address of University.
  4. Date of submittal.
  5. Name and contact information for Contractor.
  6. Name and contact information for Construction Manager.
  7. Name and contact information for Architect/Engineer.
  8. Name and contact information for Commissioning Authority.
  9. Names and contact information for major consultants to the Architect/Engineer that designed the systems contained in the manuals.
  10. Cross-reference to related systems in other operation and maintenance manuals.
- D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. 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.
- G. 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.
- H. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size and enable OCR (optical character recognition) to provide searchable text.
  2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

- I. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
  1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in minimum 1 inch and maximum 2 inch thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
  3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
  4. Supplementary Text: Prepared on 8-1/2-by-11-inch, 20 lb., white bond paper.
  5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.3 SYSTEMS, SUBSYSTEMS AND EQUIPMENT OPERATION AND MAINTENANCE MANUALS

- A. General: Provide operation and maintenance manuals where indicated in individual Specification Section and the following:
  1. Heating, ventilating and air-conditioning equipment and systems.
  2. Plumbing equipment and systems.
  3. Special piping equipment and systems.
  4. Electrical distribution systems.
  5. Standby generator systems.
  6. Communications systems.
  7. Fire alarm and detection systems.
  8. Underground sprinkler systems.
  9. Automatic entrances.
  10. Food service equipment.
  11. Elevators.
  12. Other special construction and conveying systems.
- B. Operation Content: In addition to requirements in this Section, include operation data required in individual Specification Sections.
  1. Additional Operation Content Required:

- a. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - b. Performance and design criteria if Contractor has delegated design responsibility.
  - c. Operating standards.
  - d. Operating procedures.
  - e. Operating logs.
  - f. Wiring diagrams.
  - g. Control diagrams.
  - h. Piped system diagrams.
  - i. Precautions against improper use.
  - j. License requirements including inspection and renewal dates.
2. Descriptions: Include the following:
    - a. Product name and model number. Use designations for products indicated on Contract Documents.
    - b. Manufacturer's name.
    - c. Equipment identification with serial number of each component.
    - d. Equipment function.
    - e. Operating characteristics.
    - f. Limiting conditions.
    - g. Performance curves.
    - h. Engineering data and tests.
    - i. Complete nomenclature and number of replacement parts.
  3. Operating Procedures: 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. Instructions on stopping.
    - f. Normal shutdown instructions.
    - g. Seasonal and weekend operating instructions.
    - h. Required sequences for electric or electronic systems.
    - i. Special operating instructions and procedures.
  4. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
  5. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.
- C. Maintenance Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
1. Source Information: Provide the following information in a list for each product included in manual:
    - a. Name, address, and telephone number of Installer or supplier and maintenance service agent.
    - b. Name, address, and telephone number of local source for supply of replacement parts.
    - c. Name, address, and telephone number of maintenance contractor, where appropriate.
    - d. Cross-reference Specification Section number and title.
    - e. Drawing or schedule designation or identifier where applicable.



2. **Manufacturers' Maintenance Documentation:** Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - a. Standard maintenance instructions and bulletins.
  - b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - c. Identification and nomenclature of parts and components.
  - d. List of items recommended to be stocked as spare parts.
3. **Maintenance Procedures:** Include the following information and items that detail essential maintenance procedures:
  - a. Test and inspection instructions.
  - b. Troubleshooting guide.
  - c. Precautions against improper maintenance.
  - d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - e. Aligning, adjusting, and checking instructions.
  - f. Demonstration and training video recording, if available.
4. **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.
5. **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.
6. **Maintenance Service Contracts:** Include copies of maintenance agreements with name and telephone number of service agent.
7. **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.
  - b. Include information sheet covering proper procedures in event of failure and instances which might affect validity of warranties and bonds.

#### 2.4 PRODUCT MAINTENANCE MANUALS

- A. **Content:** Organize manual into a separate section for each product, material, and finish. Separate into two manuals: one for exterior moisture protection products and those exposed to weather and one for interior products. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. **Source Information:** Provide the following information for each product included in manual:
  1. Name, address, and telephone number of Installer or supplier and maintenance service agent.
  2. Cross-reference Specification Section number and title.
  3. Drawing or schedule designation or identifier where applicable.
- C. **Product Information:** Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

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

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

## 2.5 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

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

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

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

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.6 FRAMED OPERATING AND MAINENANCE INSTRUCTIONS

- A. All mechanically and electrically operated equipment and controls shall be provided with legible and complete wiring diagrams, schematics, operating instructions, and pertinent preventative maintenance instructions in a sturdy frame with clear glass or plastic cover. Use non-fading, permanent media.
- B. Locate frames in the same room or service enclosure as equipment, or in the nearest mechanical or electrical room.

PART 3 - EXECUTION (Not Used)

**END OF SECTION 01 78 23**

## SECTION 01 78 39

### 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. Section includes administrative and procedural requirements for project record documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
  - 4. Record Samples.
  - 5. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 01 73 00 "Execution" for final property survey.
  - 2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
  - 3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

##### 1.3 CLOSEOUT SUBMITTALS

- A. General: Submit record drawings with duplicate original transmittal letters containing:
  - 1. Date.
  - 2. Project title and number.
  - 3. Contractor's name and address.
  - 4. Certification that each document as submitted is complete and accurate.
  - 5. Signature of authorized representative of the Contractor.
- B. Record Drawings: Submit copies of record Drawings as follows:
  - 1. Submit three paper-copy sets of marked-up record prints, two copies will be retained by the University and one copy retained by the Architect/Engineer.
  - 2. Submit three paper-copy sets and three digital copies on CD of electronic files for all delegated-design submittals. Two copies will be retained by the University and one copy retained by the Architect/Engineer.
- C. Record Specifications: Submit three paper copies of Project's Specifications, including addenda and contract modifications. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

- D. Record Product Data: Submit three paper copies of each submittal. Two copies will be retained by the University and one copy retained by the Architect/Engineer.
  - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- E. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit three paper copies of each submittal. Two copies will be retained by the University and one copy retained by the Architect/Engineer.
- F. Interior Finishes Binder: Three copies. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

## PART 2 - PRODUCTS

### 2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding archive photographic documentation.
    - f. Mark using line types and symbols conforming to Contract Documents.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations below first floor.
    - d. Locations and depths of underground utilities referenced to permanent surface improvements.
    - 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 referenced to visible and accessible features of structure.
    - j. Locations of concealed valves, dampers, controls, balancing devices, junction boxes, cleanouts, and other items requiring access or maintenance.
    - k. Changes made by Change Order.
    - l. Changes made following Architect/Engineer's written orders.
    - m. Details not on the original Contract Drawings.
    - n. Field records for variable and concealed conditions.

- o. Record information on the Work that is shown only schematically.
      3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
      4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
      5. Mark additional information important to University that was either shown schematically or omitted from original Drawings.
      6. Note Change Order numbers, and similar identification, where applicable.
- B. Record Delegated Design Electronic Files: For all delegated design submittals, including but not limited to landscape irrigation, fire alarm and fire sprinkler plans, prepare electronic files in full compliance with University of Colorado Denver | Anschutz Medical Campus Guidelines and Design Standards, Part 1.0, Paragraph "Drawing Production Standards."
- C. Identification: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Architect/Engineer.
    - e. Name of Contractor.

## 2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
  1. Give particular attention to substitutions, selection of options, and similar information on concealed products and installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Note related Change Orders where applicable.
  4. Maintain one complete copy of all Addenda, Change Orders and other written change documents in printed form during construction.

## 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Directory: Include record Product Data directory organized by Specification Section number and title.

- C. Product List: Update and record any changes to Product List submitted in accordance with Section 01 60 00 "Product Requirements", including any changes to brand, model, subcontractor, or Installer so that final list reflects materials, equipment and systems incorporated into the Work.

## 2.4 RECORD SAMPLES

- A. Prior to Final Acceptance, meet with University Project Manager and Architect/Engineer at site to review and identify which submitted samples maintained during the progress of the Work are to be transmitted to the University.
- B. Deliver selected samples to storage area identified by University.
- C. Finishes Binder: Three-ring notebook or notebooks, organized by Specification Section number, providing a listing and description of all material finishes on the Project and including a minimum 6 inch by 6 inch sample thereof to accompany the description. Accompany each material selection indicated with the following:
  - 1. Manufacturer and product name.
  - 2. Pattern name and number, as applicable.
  - 3. Color name, as applicable.
  - 4. Any additional information required to order replacement product.

## 2.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
  - 1. Include manufacturer's certifications, field test record, copies of permits, licenses, certifications, inspection reports, releases, notices, receipts for fee payments and similar documents.
- B. Directory: Include miscellaneous record submittals directory organized by Specification Section number and title.

## PART 3 - EXECUTION

### 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project. Update at least weekly.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect/Engineer's and University's reference during normal working hours.

**END OF SECTION 01 78 39**

## SECTION 01 79 00

### 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. Section includes administrative and procedural requirements for instructing University's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include outline for each training module.
- B. Qualification Data: For instructor, demonstrating qualifications and ability to instruct on maintenance and care of system, equipment and products.
- C. Schedule of Demonstration and Training: Prepare a schedule in tabular form of all demonstration and training required in individual Specification Sections including:
  - 1. Specification Section number and title.
  - 2. Description of required demonstration and training.
- D. Attendance Record: For each training module, submit list of participants and length of instruction time.

##### 1.4 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training. Manufacturer's sales staff is not acceptable.
- B. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training.



## 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 Specification Sections.
- B. Training Modules: For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 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.
    - g. A tour of the installation identifying the location of all system components.
  - 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.
  - n. Sequence of operation.
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.
  - f. Product support/service model.
  - g. Purchasing of replacement parts.
9. Instruction specific to Instrumentation and Controls, Electrical Gateway, Network Lighting Controls, or any other new technology that is integrated with another system: Include the following:
- a. Overview and theory.
  - b. Wiring diagrams, including the one line diagram.
  - c. Creation, editing, and programming of the point database.
  - d. Integration topology and platform for communication.
  - e. Graphics packages and touch screens for the system.
  - f. Alarms and diagnostics.
  - g. Reporting functions dynamically and historically.
  - h. Remote access to the system.
  - i. Database back-up and maintenance.
  - j. Replacement and re-programming of replacement parts.
  - k. Point type and functionality for each type of point.
  - l. Programming.
  - m. Point/object editing.
  - n. Loop tuning.
  - o. Help files and other troubleshooting documentation.

- p. Instruction is given by the staff that setup the integration.
- C. Operation and Maintenance Manuals: Provide appropriate Operation and Maintenance manuals in each training session so that the detail drawings and maintenance activities are outlined and discussed for each application.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module.
- B. Set up instructional equipment at instruction location.

#### 3.2 INSTRUCTION

- A. Engage qualified instructors to instruct University's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. University will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Coordinate schedule for all training with University Project Manager and provide the following:
    - a. Minimum 3 weeks notification.
    - b. Training matrix in calendar format.
    - c. Training outline for each session.
  - 2. Do not schedule training until equipment has been started up, commissioned, and is currently operating in its normal condition.
  - 3. Do not schedule overlapping training sessions.
  - 4. Schedule training sessions for a maximum of 4 hours per day; afternoons preferred.
  - 5. Provide separate training session on each system for operational/maintenance groups and user groups.
  - 6. Training sessions will be cancelled and rescheduled unless the following documentation is received:
    - a. Instruction qualifications.
    - b. Evidence that equipment has been started up, commissioned, and is currently operating in its normal condition.
    - c. Operation and Maintenance manuals.
- C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- D. Travel, Room and Board: Coordinate any out-of-state training with the University Project Manager.
- E. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION SCHEDULE

SECTION	TITLE	DESCRIPTION
23 00 00	HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)	Schedule instructional meetings for The University of Colorado Anschutz Medical Campus Facilities Operations maintenance personnel on the proper operation and maintenance of mechanical systems. Provide the project manager a minimum of 5 days notice prior to any testing.
23 08 00	COMMISSIONING OF HVAC	Engage the commissioning authority to provide a customized one to two day training class for the university's engineering personnel in problem solving techniques including the review of mechanical system design as a whole, integrated unit, unique qualities of the installed mechanical system, insights into how to solve system-wide, multi-faceted problems, and identify a variety of resources to assist with problem solving.
23 09 00	INSTRUMENTATION AND CONTROLS	Engage a factory-authorized trained representative to conduct a minimum of 1-four hour on-site training course and an additional 1-four on-site training course per 25,000 sf. ft. for University personnel
		Engage a factory-authorized trained representative to conduct an 8-hour seasonal loop training.
23 21 23	PUMPS	Engage a factory-authorized service representative to train a University Representative for 2 hours of instruction for each pumping system provided.

**END OF SECTION 01 79 00**

## SECTION 09 00 00 - FINISHES

### PART 1 - GENERAL

#### 1.1 SYSTEM REQUIREMENTS

- A. Design Requirements:
1. Interior design color palette proposed by the Design Professional must meet all criteria established with input and approval by the University Campus Architect through the University Project Manager.
  2. Provide rubber base at both carpet and resilient flooring installations. Upgrades are permissible with approval of the University Campus Architect through the University Denver Project Manager.
  3. All penetrations and/or seams in materials in BSL3, Vivaria, and other similar functional areas are to be sealed, unless otherwise noted.
- B. Performance Requirements:
1. Fire-Test-Response Characteristics:
    - a. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
      - 1) Flame-Spread Index: 25 or less.
      - 2) Smoke-Developed Index: 25 or less.
      - 3) Fuel Contributed Index: 15 or less.

### PART 2 - PRODUCTS (Not Applicable)

### PART 3 - EXECUTION

#### 3.1 PREPARATION OF CONCRETE TO RECEIVE MOISTURE SENSITIVE FLOORING

- A. Prepare all concrete substrates to receive moisture sensitive floor finishes including, but not limited to, resilient sheet floor, linoleum flooring, resilient tile flooring, resinous matrix terrazzo flooring, resinous flooring, sheet carpeting and tile carpeting, according to ASTM F 710 and the following:
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate pH is between 7.0 and 9.0.
  4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 80 percent relative humidity level measurement.
- B. Provide moisture vapor emissions and alkalinity control system to all concrete substrates that fail alkalinity and/or moisture testing.

**END OF SECTION 09 00 00**

## **SECTION 09 29 00 - GYPSUM BOARD**

### **PART 1 - GENERAL**

#### **1.1 SYSTEM REQUIREMENTS**

- A. Design Requirements
  - 1. Design all walls within a vivarium to have a sound transmission class (STC) rating of 55 or better.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Interior Gypsum Board:
  - 1. Gypsum board, Type X: Provide 5/8 inch thick, typical unless noted otherwise.
  - 2. Abuse-resistant gypsum board: Provide at service corridors.
  - 3. Moisture- and mold-resistant gypsum board. Provide at all high humidity areas.
- B. Exterior Gypsum Board for Ceilings and Soffits:
  - 1. Glass-mat gypsum sheathing board.
- C. Tile-Backing Panels:
  - 1. Glass-mat, water-resistant backing board.
- D. Trim Accessories:
  - 1. Interior: Paper-faced galvanized steel sheet.
  - 2. Exterior: Hot-dipped galvanized steel sheet or rolled zinc.
- E. Auxiliary Materials
  - 1. Sound attenuation blankets.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Finishing Gypsum Board Assemblies:
  - 1. Levels of Gypsum Board Finish: At a minimum, comply with recommendations in GA-214, "Recommended Levels of Gypsum Board Finish."

**END OF SECTION 09 29 00**

**SECTION 21 05 00 – COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Division 23, Section “Common Work Results for Mechanical Systems.”

**END OF SECTION 21 05 00**

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## SECTION 21 10 00

### AUTOMATIC FIRE SPRINKLER SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This section covers the design and installation of a complete fire protection system as indicated on the drawings and as specified herein consisting of the following but not limited to:
  - 1. Modify existing piping wet-type sprinkler system to match new space configuration. Modify piping and head layout. Remove and add pipe and sprinkler heads for new room and ceiling layout.
- B. The requirements of the specifications and drawings may require construction beyond that required by Code. Contractor shall provide this system, fully complying with the requirements of these contract documents.

##### 1.3 FIRE PROTECTION MEETINGS

- A. Pre-design/Pre-submittal Conference: Conduct a conference at Project site prior to commencing preparation of delegated design and other submittals specified in this Section. (Similar to Preconstruction Conference specified under Section 01 31 00 "Project Management And Coordination" but at a separate time.) Meeting may be conducted at same time as fire protection meeting specified in Section 28 31 00 "Fire Detection And Alarm."
  - 1. Attendees shall include fire protection sub-contractor, University's Code Officials (AHJ), University's Fire Technicians, University's Project Manager, and representatives of Architect and Engineer of Record.
  - 2. Invite attendees no less than 14 calendar days in advance of scheduled meeting time.
  - 3. Agenda shall include reviewing requirements for design, submittals, pre-testing/-inspection, and field quality control testing and inspection requirements, including participation of selected University personnel during inspection and testing operations.

##### 1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. It shall be the Contractor's responsibility to design, layout, and size the systems from hydraulic calculations in accordance with the requirements of NFPA 13 - Installation of Sprinkler Systems.

2. It shall be the Contractor's responsibility to design the system so that no interference exists between the fire protection system and work of other trades, equipment and systems designed and installed by others. The latest issues of all architectural, structural, mechanical, and electrical drawings will be furnished for reference to assist the Contractor in preparing the design so as to avoid interference.
3. Submitted calculations shall include flow test data used. Flow test data obtained from local authorities may be used if test has been made within three months of project start date. Flow tests performed by this Contractor shall be verified by local authorities.
4. Hydraulic calculations shall be based on 90% of flow test pressure data.
5. The Contractor shall determine/verify hazard classifications for all areas and shall identify them on the plans. Specific hazard areas include:
  - a. Light Hazard (all areas except as listed below)

B. Performance Requirements:

1. System shall provide coverage for remodel area shown on plans.
2. Provide a hydraulically designed wet-pipe sprinkler system to meet requirements of NFPA 13.
3. Interface system with building fire and smoke alarm system.

1.5 SUBMITTALS

- A. Refer to Division 01 and Division 21 Section "Common Results for Fire Suppression Systems," for general requirements.
- B. Delegated Design Submittal: Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
  2. Sprinkler shop drawings and calculations shall be sealed and signed by a licensed professional engineer (P.E.) licensed in Colorado who shall certify that the sprinkler design and installation meets requirements of the local codes and applicable sections of NFPA. Sprinkler drawings and calculations shall be prepared by an NICET III or IV designer under the direct supervision of the licensed professional engineer in responsible charge.
- C. Product Data:
  1. Piping materials
  2. Valves
  3. Sprinkler heads
  4. Fire protection specialties
- D. Shop Drawings: Prepare shop drawings showing layout of fire protection system. Drawings shall reckon with all building components and show routing of piping to clear same. Drawings shall conform to requirements of NFPA 13 "Working Plans" and shall be accurately dimensioned to show proposed location of all fire protection system components. Shop drawings shall be prepared on AutoCAD and the drawing sizes shall be the same as the Engineer's drawings.

E. Quality Assurance/Control Submittals:

1. Drawings and hydraulic calculations shall be submitted to the regulatory agencies having jurisdiction for their approvals. After approvals are obtained, the drawings and hydraulic calculations shall be submitted to the Engineer for review.
2. Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of NFPA 13.

1.6 QUALITY ASSURANCE

- A. Qualifications: The system shall be designed and installed by a firm regularly engaged in the design and installation of fire protection systems in accordance with the requirements of the National Fire Protection Association. The firm shall have had a minimum of five years of experience in fire protection system design and installation for projects of similar nature to this project. Engineer may require evidence to support the above qualifications and may reject any proposed installer who cannot show suitable experience.
- B. Regulatory Requirements:
1. Refer to Division 21 Section "Common Results for Fire Suppression Systems" for general code, standard and regulatory requirements.
  2. The fire protection system shall be in conformance with the requirements of the following regulatory agencies and codes wherever the requirements of such agencies and codes are applicable:
    - a. Local building department
    - b. Local fire department
    - c. Local water department
- C. Certifications: All materials and equipment used in the installation of the fire protection system shall be as listed in the Underwriters' Laboratories (UL) Fire Protection Equipment Directory, or the Factory Mutual Laboratories Approval Guide and fire protection devices involving fire hazard, and shall be the latest product of the manufacturer.

PART 2 - PRODUCTS

2.1 PIPES AND TUBES

A. Aboveground Downstream of the Backflow Preventer:

1. Steel Pipe: ASTM A53, Schedule 40, in NPS 6 and smaller, and Schedule 30, in sizes NPS 8 and larger, carbon steel and galvanized. Schedule 30 and Schedule 40 "equivalent" or "replacement" having a wall thickness less than Schedule 30 or Schedule 40, respectively, is not allowed.
  - a. Acceptable fitting/joint types for use with this pipe:
    - 1) Threaded
    - 2) Welded
    - 3) Cut-groove
    - 4) Rolled-groove

2. Steel Pipe: ASTM A135, Schedule 10, through NPS 5 sizes and NFPA 13 specified wall thickness for NPS 6 through NPS 10, carbon steel and galvanized. Schedule 10 "equivalent" or "replacement" having a wall thickness less than Schedule 10 is not allowed.
  - a. Acceptable fitting/joint types for use with this pipe:
    - 1) Welded
    - 2) Rolled-groove
3. Steel Pipe: ASTM A795, Standard and Light Weight Fire Protection Pipe.
  - a. Standard Weight Fire Protection Pipe Schedule 40, sizes NPS 6 and smaller. Schedule 40 "equivalent" or "replacement" having a wall thickness less than Schedule 40 is not allowed.
    - 1) Acceptable fitting types for use with standard weight (Schedule 40), carbon steel and galvanized.
      - a) Threaded
      - b) Welded
      - c) Cut-groove
      - d) Rolled-groove
  - b. Standard Weight Fire Protection Pipe, Schedule 30, only allowed in sizes NPS 8 and larger. Schedule 30 "equivalent" or "replacement" having a wall thickness less than Schedule 30 is not allowed.
    - 1) Acceptable fitting types for use with standard weight (Schedule 30), carbon steel and galvanized.
      - a) Threaded
      - b) Welded
      - c) Cut-groove
      - d) Rolled-groove
  - c. Light Weight Fire Protection Pipe Schedule 10. Schedule 10 "equivalent" or "replacement" having wall thickness less than Schedule 10, respectively, are not allowed.
    - 1) Acceptable fitting/joint types for use with this pipe:
      - a) Welded
      - b) Rolled-groove
4. Pipe and fitting/joints not explicitly described above are not acceptable.

## 2.2 PIPE AND TUBE FITTINGS

- A. Cast Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, with threads according to ANSI B1.20.1.
- B. Ductile Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, with threads according to ANSI B1.20.1.

- C. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, with threads according to ANSI B1.20.1.
- D. Steel Fittings: ASTM A 234, seamless or welded; ANSI B16.9, buttwelding; or ANSI B16.11, socket-welding type for welded joints.
- E. Steel Flanges and Flanged Fittings: Class 150, ANSI B16.5.
- F. Grooved-End Fittings for Steel Pipe: UL-listed and FM-approved, ASTM A536, Grade 65-45-12 ductile iron or ASTM A47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.

### 2.3 JOINING MATERIALS

- A. Flanged Joints for Ductile Iron Pipe and Ductile Iron or Cast Iron Fittings: AWWA C115 ductile iron or gray iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.
- B. Couplings for Grooved-End Steel Pipe and Grooved-End Ferrous Fittings: UL 213, AWWA C606, ASTM A536 ductile iron or ASTM A47 malleable iron housing, with enamel finish. Include synthetic rubber gasket with central-cavity, pressure-responsive design; ASTM A183 carbon steel bolts and nuts; and locking pin, toggle, or logs to secure grooved pipe and fittings.

### 2.4 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL listed and FM approved, made of steel, ductile iron, or other materials compatible with system materials and applications where used.
- B. Locking Lug Fittings: UL 213, ductile iron body with locking lug ends, for use with plain-end steel pipe.
- C. Mechanical "T" Fittings: UL 213, ductile iron housing with pressure-responsive gaskets, bolts, and threaded or locking lug outlet.
- D. Mechanical-Cross Fittings: UL 213, ductile iron housing with pressure-responsive gaskets, bolts, and threaded or locking lug outlets.
- E. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
- F. Sprinkler Alarm Test Fittings: Ductile iron housing with NPS 1-1/2 inlet and outlet, integral test valves, combination orifice and sight glass, and threaded or locking lug ends.

### 2.5 GENERAL DUTY VALVES

- A. Bronze Two-Piece Ball Valves:
  - 1. Manufacturer and Model:
    - a. Threaded Ends:
      - 1) Apollo 77-100 Series
      - 2) FNW 420
      - 3) Nibco T-585-70

- b. Grooved Joint:
    - 1) Victaulic Series 721
  - 2. 150 psig SWP, non-shock 600 psig WOG, MSS SP-110, cast bronze, full port, two-piece body design, chrome-plated solid bronze ball with reinforced Teflon seats. Stem packing adjustable for wear with adjusting screw.
- B. Butterfly Valves:
- 1. Flangeless Ferrous Alloy Butterfly Valves
    - a. Manufacturer and Model:
      - 1) Apollo 143
      - 2) Centerline 200
      - 3) NIBCO LD 2000
    - 2. Flangeless, 200 psig CWP Rating through NPS 12, 150 psig CWP Rating NPS 14 and larger, MSSSP 67, cast or ductile iron body, wafer lug type, extended neck, aluminum bronze or nickel plated ductile iron disc, stainless steel shaft, EPDM seat and seal, 10-position lever locking handle through NPS 6, worm gear actuator for NPS 8 and larger valves.
    - 3. Grooved Ferrous Alloy Butterfly Valves
      - a. Manufacturer and Model:
        - 1) Nibco GD4765
        - 2) Victaulic Series 700/709
      - b. Grooved, 200 psig CWP Rating, MSSSP 67, EPDM or polymer coated cast or ductile iron body, extended neck, aluminum bronze or nickel plated ductile iron disc, stainless steel shaft, EPDM seat and seal, 10-position lever locking handle through NPS 6, worm gear actuator for NPS 8 and larger valves.
    - 4. Valves shall be capable for use as isolation valves and be recommended by the manufacturer for dead-end service at the full-rated operating pressure, without the need for downstream blind flanges.

## 2.6 FIRE PROTECTION SERVICE VALVES

- A. Gate Valves:
- 1. NPS 2 and Smaller – UL-262, cast bronze, threaded ends, solid wedge disc, rising stem, OS&Y, screw-in bonnet. Ball valves of same construction may be used.
  - 2. Indicating Valves, NPS 2-1/2 and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.
  - 3. NPS 2-1/2 and Larger – UL-262, iron body, bronze trim, flanged ends, solid wedge disc, rising stem, OS&Y, flanged bonnet, 175 psig non shock working pressure.
- B. Butterfly Valves: NPS 2-1/2 and Larger – Slow closing, outside indicating, ductile iron body and disk, for grooved piping, with gear operator 175 psig non shock working pressure.

- C. Swing Check Valves: Iron body, horizontal swing check with renewable bronze or stainless steel seat and seat rings, flanged or grooved ends, 175 psig non shock working pressure.

## 2.7 AUTOMATIC FIRE SPRINKLER HEADS

- A. Approved Manufacturers: Viking, Reliable, and Tyco.
- B. Sprinkler heads shall have a temperature rating of 155°F except for heads in areas of high temperature and in close proximity to heat sources that are temperature rated in accordance with NFPA 13.
- C. Sprinkler Heads in Suspended Ceilings: Pendent type, chrome plated with white escutcheon, semi-recessed style.
  - 1. In the rooms with wood ceilings , provide concealed style, rough brass with painted bright white cover plate.
- D. Sprinkler Heads in Exposed Areas: Upright type, standard brass.
- E. Guards: Provide sprinkler head guards where the sprinkler deflector is located 7'-0" or less above finished floor, or is otherwise subject to injury. Head guard finish shall match applicable sprinkler head finish requirements.
- F. Supply the Owner an extra stock of six sprinklers minimum, three of each type, and a special sprinkler wrench and a pair of sprinkler tongs. Heads shall be provided in suitable head cabinets for wall mounting next to fire service entry. Provide any additional heads that may be required by NFPA 13. Provide three extra escutcheon plates of each type installed on the project.

## 2.8 IDENTIFICATION SIGNS

- A. Identification Signs: Provide identification signs at all control, drain, test and alarm valves. Signs shall be of the type, size and location as required by NFPA.

## 2.9 FIRE HOSE CONNECTION

- A. Approved Manufacturers: Potter-Roemer or equivalent.
- B. Coordinate fire hose connection with fire hose cabinet and fire extinguisher as specified in Division 10.
- C. Provide an NPS 2-1/2 hose valve with NPS 2-1/2 x NPS 1-1/2 reducer with pin lug cap and chain equal to Potter-Roemer 4065.

## 2.10 FIRE HOSE CABINET

- A. Approved Manufacturers: Potter-Roemer or equivalent.
- B. Provide recessed 20-gauge, white, baked enamel steel box fire hose cabinet, 20-gauge tubular steel door with 18-gauge frame with a continuous steel hinge (brass pin), door and frame finished with a baked-on gray prime coat equal to Potter-Roemer 1500-A.

- C. Provide NPS 2-1/2 hose valve with NPS 2-1/2 x NPS 1-1/2 reducer with pin lug cap and chain equal to Potter-Roemer 4065 and a multipurpose dry-chemical type fire extinguisher in brass container: UL-rated 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in chrome-plated brass container.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Entire installation shall be in accordance with approved shop drawings, local codes, and applicable NFPA requirements. When unforeseen job site conditions will not permit piping to be installed as shown on the drawings, necessary changes will be made to accomplish a coordinated system without additional cost to the Owner, even though pipe may have been delivered to the site cut to predetermined lengths. Pipe hanger spacing shall conform to the requirements of the NFPA.
2. Locate all valves where readily accessible. All main line valves shall be electrically monitored or secured with a chain and padlock that will lock the valve in an open position.
3. Provide valved test drains as required by NFPA. Pipe test drains, through drain risers where necessary, to the nearest adequate floor drain. Not all sprinkler drains or sprinkler system test drains are shown. Contractor shall be responsible for providing additional sprinkler drains as required. Contractor shall provide additional floor drains and associated waste and vent piping as required at each sprinkler drain location. "
4. Make provisions to drain all parts of the piping system.

#### B. Pipe installations comply with provisions of applicable sections in Division 2315 specification.

#### C. Automatic Fire Sprinkler Head Installation:

1. Pendent and upright heads shall be installed with the deflectors parallel to the ceiling; clearance between the deflectors and the ceilings, roof decking, roof joints, electric or heating equipment, or other obstructions shall be in accordance with the requirements of NFPA.
2. In those areas where lay-in acoustical tile ceilings are to be installed, install all sprinkler heads in the ceiling tiles centered within 6 inches of tile center.
3. Remove all sprinkler head frangible bulb protectors after sprinkler head installation. Protect all recessed and concealed sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

#### D. Fire Hose Cabinet Installation: Branch piping to valves must have rigid bracing independent of fire hose cabinet.

#### E. Fire Alarm Wiring: All fire alarm and monitor wiring shall be done under the Electrical Division but the proper operation shall be the fire protection contractor's responsibility.

### 3.2 FIELD QUALITY CONTROL PIPE TESTING

- A. Site Tests/Inspection: The entire fire protection piping system including the underground service piping shall be tested hydrostatically at not less than 200 psig pressure for two hours, or at 50 psig in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psig. The hydrostatic



test pressure shall be measured at the low point of the individual system or zone being tested. Refer to NFPA 13, Chapter 8 for additional requirements.

### 3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 21 10 00**

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## SECTION 23 05 00 – COMMON WORK RESULTS FOR MECHANICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.
- B. All electrical work installed under Division 23 shall be in compliance with Division 26.

#### 1.2 DRAWINGS AND SPECIFICATIONS

- A. The drawings are diagrammatic in character indicating design concept and do not indicate every required duct or piping offset, valve, fitting, etc.
- B. All drawings relating to this structure, together with these specifications, shall be considered in bidding and construction. The drawings and specifications are complementary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict or omissions arise between the drawings and specifications, such conflict shall be brought to the attention of the Architect/ Engineer for resolution.
- C. Unless otherwise indicated, all equipment and performance data listed is for job site conditions (elevation 5300 feet).
- D. Drawings are not to be scaled.

#### 1.3 DEFINITIONS

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

G. The following are industry abbreviations for rubber materials:

1. EPDM – Ethylene propylene diene terpolymer rubber
2. NBR – Acrylonitrile-butadiene rubber

#### 1.4 SUBMITTALS

A. Division 23 Submittal Data and Shop Drawings:

1. Refer to Division 01, for general submittal requirements.
2. Contractor agrees that shop drawings and/or submittals processed by the Engineer are not change orders; that the purpose of shop drawings and/or submittals by the Contractor is to inform the Engineer which equipment and materials he intends to furnish and install.
3. Submittals and/or shop drawings are to be edited to show specific data and all options for the HVAC equipment that the Contractor intends to provide.
4. Submittals and/or shop drawings are to be identified with numbers or letters identical to those listed on the drawings and/or specifications.
5. All shop drawings for special systems (temperature controls, etc.) that will become permanent record documents shall be prepared on AutoCAD Version 2007 or later, using the same drawing size as the project construction documents.
6. Approved Manufacturers and Substitutions:
  - a. Equipment and/or materials manufactured by any one of the Engineer-approved manufacturers listed in this specification or on the drawings shall be acceptable if the equipment and material is equivalent in performance, capacity, and configuration.
  - b. Substitution Requests prior to bid: Refer to Division 01. No prior approvals will be given by the Engineer unless specifically mentioned in these specifications.
  - c. Substitution Requests after Execution of Contract: If Contractor wishes to furnish or use a substitute item of material and/or equipment, he must submit a change order request to the Engineer. The request for change order shall itemize each of the proposed substitutions identified by applicable specification section, paragraph number, and/or drawing number. A price change (increase or decrease) shall be listed for each item along with complete data showing performance over entire range, physical dimensions, electrical characteristics, material construction, operating weight, and other applicable data. Justification of substitution must be more than just cost justification. The Engineer will review the change order request for equality, suitability, and reasonableness of price differential. A single substitution change order listing the approved items will be issued with the net cost of the change order being the sum of the approved item costs. No subsequent substitution change orders will be considered. The Engineer's decision will be final.
  - d. It shall be the responsibility of the Contractor to assure that the substitute material and/or equipment fits into the space provided and the Contractor shall pay for all extra costs incurred by other trades for any and all changes necessitated by these substitutions. No time extension will be allowed due to substitution on equipment.
  - e. Equipment and/or materials manufactured by any one of the Engineer-approved manufacturers listed in this specification or on the drawings shall be acceptable if the equipment and material is equivalent in performance, capacity, and configuration.
7. Submittals Schedule: Comply with Division 01 construction progress documentation and submittal requirements and the additional submittal requirements specified below. Unless otherwise specified in Division 01, comply with the submittal periods specified below. Engineer will schedule submittal reviews based upon submittal schedule. Failure to submit schedule may result in inability to review submittals within the periods stated in the submittal schedule. These delays shall not be cause for extension of Contact completion date.

- a. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
  - b. Submit schedule within 14 days of commencement of work. Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  - c. Allow 15 days for review of each resubmittal.
  - d. Submit a minimum of three copies of schedule. Arrange the following information in a tabular format:
    - 1) Scheduled date for first submittal.
    - 2) Specification Section number and title.
    - 3) Submittal category (action or informational).
    - 4) Name of subcontractor.
    - 5) Description of the Work covered.
    - 6) Scheduled date for Architect's final release of reviewed submittal.
8. Schedule of Deviations: Equipment and material submittals of approved manufacturers, including basis of design manufacture shall provide a written itemization of exceptions to the specification and deviations from the basis of design for all features, design, configuration, physical dimension, performance, and operation of the submitted product. Those elements not identified and itemized as exceptions in the submittal shall not be reviewed by the Engineer and shall be provided as specified.

B. Schedules:

1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
2. Valve numbering scheme.
3. Valve Schedules: For each piping system to include in maintenance manuals.

C. Close-out Submittals:

1. Operating and Maintenance (O&M) Manual:
  - a. Provide O&M manuals in accordance with Division 01.
  - b. The Contractor shall prepare an operating and maintenance manual that shall cover all systems and equipment installed under this Division. Incorporate the standard technical literature into system-specific formats for this facility as designed and actually installed. The resulting manual shall also serve as the training manual and shall be specific, concise, to the point, and tailored specifically for this facility.
  - c. Unless specified otherwise in Division 01, the maintenance manual shall be submitted to the Engineer in draft form for approval prior to preparation of two copies for final submission to the Architect for delivery to the Owner.
  - d. The maintenance manual shall be 8-1/2" x 11" size and assembled in loose-leaf 3-ring or post binder. Provide manufacturers' original literature. Facsimiles are not acceptable. The manual shall be adequately indexed and contain the following information:
    - 1) Contractors' names, addresses, and telephone numbers
    - 2) Alphabetical list of all system components with the name and address and 24-hour phone number of the company responsible for servicing each item during the first year of operation
    - 3) Guarantees and warranties of all equipment whenever applicable.

- 4) All manufacturers' data that is applicable to the installed equipment, with appropriate highlighting, such as the following:
    - a) Shop drawings (latest copy)
    - b) Installation instructions
    - c) Lubrication instructions
    - d) Wiring diagrams
  - 5) A simplified description of the operation of all systems including the function of each piece of equipment within each system, including both normal and emergency operations. These descriptions shall be supported with a schematic flow diagram when applicable.
2. Record Drawings:
- a. Comply with record drawing requirements in Division 01.
  - b. Record Prints: All RFIs, change orders and other directives if not recorded on the contract drawings and amendments shall be red-lined on the record drawings. Record drawings simply tabulating the amendments onto the drawings shall be returned for clarification of installed conditions and red-line mark-up.
- D. Non-Responsive Submittals: Submittals are intended to be reviewed in an initial submittal with comments corrected and submitted in a resubmittal. Non-responsiveness to the initial submittal comments in the resubmittal will result in return of the documents for correction and additional resubmittals. Any time charged by the Engineer in review of additional resubmittals due to non-responsiveness shall be deducted from the Contractor's billings.
- E. Product Data:
1. Transition fittings
  2. Dielectric fittings
  3. Mechanical sleeve seals
  4. Escutcheons
  5. Motor Submittal Data: The following data shall be submitted for all motors:
    - a. Full load current and service factor running current at operating voltage.
    - b. Locked rotor current, starting power factor, and power factor at full load.
    - c. Efficiency at full load.
    - d. Data to substantiate Class F insulation with Class B rise at 100% load.
    - e. Full load speeds (rpm).
    - f. Enclosure type (ODP, TEFC, explosion proof, TENV, WPI, etc.)

*Note: All tests (except locked rotor current) shall be made at full voltage and rated frequency.*
  6. Motor Controllers:
    - a. Torque, speed, and horsepower requirements of the load.
    - b. Ratings and characteristics of supply circuit and required control sequence.
    - c. Ambient and environmental conditions of installation location.
  7. Capacitor size (KVAR) for maximum power factor correction at 95% lagging.
  8. Identification: Submit product for each type of identification.
- F. Certification: Welders' certification.

### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code – Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of lower or higher electrical characteristics may be furnished provided such proposed equipment variations are specifically identified as a deviation from contract documents and approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost to the Owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support piping to prevent sagging and bending.

### 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.
- D. Identification:
  - 1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
  - 2. Coordinate installation of identifying devices with locations of access panels and doors.
  - 3. Install identifying devices before installing acoustical ceilings and similar concealment.
- E. Coordinate with all trades to maintain clearances to access panels, equipment, control and electrical panels. Intrusions into access space shall be brought to the attention of other trades. Notify Engineer of conflicts shown on drawings prior to installation.
- F. Prior to fabricating work or commencing the work, Contractor shall prepare coordination drawings combining disciplines of all trades prior to installation of systems and equipment. Indicate architectural, structural, HVAC, plumbing, fire protection, electrical, and telecommunications. Drawings shall correlate with elements of all trades to predict and prevent conflicts and identify pathways and adequate space. Drawings shall identify required access to equipment and panels and shall identify zones over electrical panels and equipment to be free of ductwork and piping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles throughout Divisions 21, 22, and 23 where subparagraph titles introduce lists of manufacturers, the following requirements apply for product selection:
1. Subject to compliance with requirements, provide products by one of the manufacturers listed.
  2. Manufacturers other than the ones listed may be proposed under the provisions for Substitutions in Division 01.

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 HVAC piping Sections for pipe, tube, and fitting materials and joining methods.
1. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 HVAC piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2 mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  2. AWWA C110, rubber, flat face, 1/8 inch thick (3.2 mm thick), unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
1. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
    - a. CPVC solvent cement used on any portion of below grade pipe extending into building envelope shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).



- b. Adhesive primer used on any portion of below grade pipe extending into building envelope shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - c. Solvent cement and adhesive primer used on any portion of below grade pipe extending into building envelope 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. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- a. PVC solvent cement used on any portion of below grade pipe extending into building envelope shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - b. Adhesive primer used on any portion of below grade pipe extending into building envelope shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - c. Solvent cement and adhesive primer used on any portion of below grade pipe extending into building envelope 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 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- 1. Available Manufacturers:
    - a. Cascade Waterworks Mfg. Co.
    - b. Dresser Industries, Inc.DMD Div.
    - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
    - d. JCM Industries.
    - e. Smith-Blair, Inc.
    - f. Viking Johnson
  - 2. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- 1. Available Manufacturer: Eslon Thermoplastics
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- 1. Available Manufacturer: Thompson Plastics
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- 1. Available Manufacturers:
    - a. NIBCO Inc.
    - b. NIBCO, Inc.; Chemtrol Division

- E. Flexible Transition Couplings for Underground Non-Pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:
  - a. Cascade Waterworks Mfg. Co.
  - b. Fernco, Inc.
  - c. Mission Rubber Co.
  - d. Plastic Oddities, Inc.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Use dielectric couplings.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig (1035 or 2070 kPa) minimum working pressure as required to suit system pressures.

1. Available Manufacturers:
  - a. Capitol Manufacturing Co.
  - b. Central Plastics Co.
  - c. Epco Sales, Inc.
  - d. Watts Industries, Inc.; Water Products Division

- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Co.
  - d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150 or 300 psig (1035 or 2070 kPa) minimum working pressure where required to suit system pressures.

- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig (2070 kPa) minimum working pressure at 225°F (107°C).

1. Available Manufacturers:
  - a. Calpico, Inc.
  - b. Lochinvar Corp.

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Available Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
    - e. PSI/Thunderline/Link-Seal
  2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  3. Pressure Plates: Zinc dichloromate or glass reinforced plastic. Include two for each sealing element.
  4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.610 mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

## 2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass.
    - a. Finish: Polished chrome-plated.
  2. One-Piece, Cast-Brass Type: With set screw.
    - a. Finish: Polished chrome plated.
  3. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
    - a. Finish: Polished chrome plated.
  4. One-Piece, Floor-Plate Type: Cast-iron floor plate.
  5. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.9 GROUT

- A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  3. Packaging: Premixed and factory packaged.

## 2.10 ELECTRIC MOTORS

- A. General: All motors (except as noted) shall conform to the following specifications:
1. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or sections.
  2. 1/2 hp (0.37 kW) and Smaller: Single-phase.
  3. Larger than 1/2 hp (0.37 kW) shall be 3-phase, except where specifically noted otherwise.
  4. Comply with NEMA MG 1 unless otherwise indicated.
  5. Motors shall be UL listed for intended use.
- B. Motor Characteristics:
1. Duty: Continuous duty at ambient temperature of 40°C and at site elevation.
  2. 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.
- C. Single Phase Motors:
1. Motors shall be in compliance with DOE Energy Conservation Standards for Small Electric Motors
  2. Motors shall be one of the following, to suit starting torque and requirements of specific motor application:
    - a. Permanent-split capacitor (PSC).
    - b. Split phase.
  3. Multispeed Motors:
    - a. Electronically commutated motor (ECM): Provide ECM motors with speed control when available as an option.
    - b. Variable-torque, permanent-split-capacitor type.
  4. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
  5. 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.
- D. Electrically Commutated Motors
1. Motor shall be electronic commutation (EC) type specifically designed for application.
  2. Motors shall be permanently lubricated with heavy duty ball bearings to match the driven load.
  3. Motor speed shall be speed controllable down to 20% of full speed (80% turndown.)M

4. Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Both capabilities shall be provided.

## 2.11 MOTOR CONTROLLERS

### A. General Motor Controller Characteristics:

1. Single speed and multi-speed motor controllers shall be combination type, full NEMA-rated IEC NEMA-Equivalent starters with motor circuit protector fused or non-fused disconnect switch for all motors provided.

*Exception: Starters that are shown to be provided integral within packaged equipment, control panels with door mounted disconnects or in motor control centers.*

2. All starters, whether separately furnished or integral with equipment, shall comply with the following:
  - a. Enclosures: NEMA Type 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA Type 4 with conduit hubs, or units in hazardous locations that shall have NEC proper class and division explosion-proof enclosure.
  - b. Single-phase Starters: Starters shall be shall be horsepower-rated thermal overload switches.

## 2.12 MISCELLANEOUS ELECTRICAL DEVICES

- A. Furnish all necessary control devices such as speed controls, transformers, and relays as required for proper operation of all equipment furnished under this Division.
- B. Furnish all remote switches and/or pushbutton stations required for manually operated equipment complete with low energy pilot lights of an approved type.
- C. Enclosures: NEMA Type 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA Type 4 with conduit hubs, or units in hazardous locations that shall have NEC proper class and division explosion proof enclosure.
- D. Furnish circuit and purpose identification for each remote manual switch and/or pushbutton station furnished herein. Identification may be either engraved plastic sign for permanent mounting to wall below switch, or stamping on switch cover plate. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

## 2.13 ACCESS PANELS OTHER THAN SHEET METAL

- A. Refer to Division 08 for specification of access doors.
- B. Access panels are to have Underwriters' Laboratories B label fire rating when installed in fire-rated walls or ceiling.
- C. Access panels for installation in plaster are to be similar to Milcor style "K," all other access panels are to be similar to Milcor style "M."
- D. Panels located in public areas are to have keyed locks.

## 2.14 IDENTIFICATION

### A. Equipment Labels:

#### 1. Metal Labels for Equipment:

- a. Material and Thickness: Brass, 0.032-inch (0.77 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
- b. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 x 3/4 inch (65 x 20 mm).
- c. Minimum Letter Size: 1/4 inch (6 mm) for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- d. Fasteners: Stainless steel rivets or self-tapping screws.
- e. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### 2. Plastic Labels for Equipment:

- a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- b. Letter Color: White.
- c. Background Color: Black.
- d. Maximum Temperature: Able to withstand temperatures up to 160°F (71°C).
- e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 x 3/4 inch (65 x 20 mm).
- f. Minimum Letter Size: 1/4 inch (6 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (15 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- g. Fasteners: Stainless steel rivets or self-tapping screws.
- h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### 3. Label Content: Include equipment's unique equipment number.

4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2" x 11" (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the specification section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### B. Pipe Labels:

1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
5. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - a. 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.
  - b. Lettering Size: At least 1-1/2 inches (40 mm) high.

C. Stencils:

1. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 2 inches (50 mm) for ducts; and minimum letter height of 3/4 inch (20 mm) for access panel and door labels, equipment labels, and similar operational instructions.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Exterior, gloss enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior enamel in colors according to ASME A13.1 unless otherwise indicated.

D. Valve Tags:

1. Valve Tags: Stamped or engraved with 1/4-inch (6 mm) letters for piping system abbreviation and 1/2-inch (15 mm) numbers.
  - a. Tag Material: Brass, 0.032-inch (0.77 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - b. Fasteners: Brass wire-link or beaded chain; or S-hook.
2. Valve Schedules: For each piping system, on 8-1/2" x 11" (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - a. Valve-tag schedule shall be included in operation and maintenance data.

2.15 SECURITY FASTENERS

- A. Security Fasteners: Provide security fasteners for all Division 23 items mounted in secured areas. Security fasteners shall be 5-lobe "TORXplus" as manufactured by TAMPER-PRUF SCREWS, Paramount, California.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Divisions 01 and Division 02 for general demolition requirements and procedures.
- B. Disconnect and remove HVAC systems, equipment, and components indicated to be removed.
  1. Piping To Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  2. Piping To Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  3. Equipment To Be Removed: Disconnect and cap services and remove equipment.
  4. Equipment To Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  5. Equipment To Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying HVAC piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Insulated Piping: Split, cast-brass type with spring clips.
    - c. Bare Piping at Wall, Floor, and Ceiling Penetrations in Finished Spaces, Unfinished Service Spaces, and Equipment Rooms: One-piece or split, cast-brass type with polished chrome-plated finish.
  - 2. Existing Piping: Use the following:
    - a. Insulated Piping: Split, cast-brass type with spring clips.
    - b. Bare Piping at Wall, Floor, and Ceiling Penetrations in Finished Spaces, Unfinished Service Spaces, and Equipment Rooms: Split, cast-brass type with polished chrome-plated finish.
- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.



*Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.*

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  3. Install sleeves that are large enough to provide 1/4-inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials, seismic installation may require additional clearance:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions. Seal space outside of sleeve fittings with grout.
  4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
- P. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch w.g. (2.49 Pa).
1. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
  2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated
  3. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch w.g. (74.7 Pa).
  4. Submit the firestopping systems proposed including the system number, ratings, testing laboratory, and installation detail.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other sections of these specifications for roughing-in requirements.
- S. Install dielectric fittings or approved adaptor fittings on all joints between different piping materials on steam, hot water, chilled water, condenser water, steam condensate, ground source heat pump loop systems and other hydronic mechanical piping systems.
- T. Old Pipe Lines: If any old sewer, water, gas, or other pipes are encountered that interfere with the proper installation of new work and that will not be used in connections with the new work, close all openings in proper manner or, if necessary, relocate or remove the pipes as shown on plans. Should any old pipes and/or electrical lines not shown on plans be encountered, immediately notify Owner's representative before taking any action.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.4 ACCESS PANELS

- A. Furnish access panels where required for access to concealed HVAC items such as dampers, valves, strainers, shock absorbers, cleanouts, control devices, and where required for equipment servicing.
- B. Deliver all panels to General Contractor for installation. Provide instructions for their location in sufficient time so panels can be installed in the normal course of work.

### 3.5 IDENTIFICATION COMMON REQUIREMENTS

- A. Preparation: 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.
- B. Equipment Label Installation:
  - 1. Install or permanently fasten labels on each major item of HVAC equipment.
  - 2. Locate equipment labels where accessible and visible.
- C. Pipe Label Installation:
  - 1. Piping Color-Coding: Painting of piping is specified in Division 09.

2. 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:
    - a. Near each valve and control device.
    - b. Near each valve and control device.
    - c. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
    - d. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
    - e. At access doors, manholes, and similar access points that permit view of concealed piping.
    - f. Near major equipment items and other points of origination and termination.
    - g. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (8 m) in areas of congested piping and equipment.
    - h. Piping colors shall be per ANSI A13.1
  - D. Valve Tag Installation: 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.
    1. Valve Tag Application: Tag all valves with indicating service and number. Tags 1-1/2 inches (40 mm) in diameter, brass, with 1/4-inch-high (6 mm-high) letters. Securely fasten with chain and hook. Match service abbreviations given on HVAC drawings.
- 3.6 PAINTING
- A. Painting of HVAC systems, equipment, and components per campus standards for interior painting and exterior painting. Coordinate with campus project manager.
  - B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES
- A. Refer to Division 05 for structural steel and Section 23 05 48 "Wind, Seismic, and Vibration Controls for Mechanical Systems" for additional requirements.
  - B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical piping, materials and equipment.
  - C. Field Welding: Comply with AWS D1.1.
- 3.8 CLEANING
- A. Cleaning and Flushing:
    1. All water circulating systems for the project shall be thoroughly cleaned before placing in operation to rid the system of dirt, piping compound, mill scale, oil, and any and all other material foreign to the water being circulated.
    2. Extreme care shall be exercised during construction to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped, and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and all dirt removed.

- a. Heating Water Systems: Hot water heating systems, including converters, pumps, coils, and piping shall be cleaned with a solution of trisodium phosphate. This cleaning also applies to glycol systems prior to filling. Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 24 hours. Remove heat and allow to cool; then drain and refill with clean water. Circulate for 6 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed.
  - b. Chilled Water Systems: Circulate cleaning chemicals for 48 hours, then drain. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed.
3. After the system (or portion thereof) has been leak tested, thoroughly flush with clean water. During the clean water flush, all valves shall be full open, the flow rate for flush shall be at least 4 ft./sec., and the total flow shall equal at least five times the total piping system volume. Flushing shall continue until water runs clear.
  4. After clear water flushing is complete, a chemical flushing solution, shall be utilized to remove oil, grease, piping compounds, etc. After the system is filled with this solution, the system shall be brought up to temperature and allowed to circulate for at least eight hours. The system shall then be drained completely and reflushed with fresh water.
  5. After the system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable method and shall be left on the slightly alkaline side (pH = 7.5+). If the system is found to be still on the acid side, the chemical flush shall be repeated as necessary.
  6. The Owner's representative shall be given notice of this cleaning operation. If the Owner's representative deems it necessary, the cleaning operation shall be repeated.
  7. "Stop-Leak" compounds shall not be added to the system at any time.
  8. Immediately after clear water flushing is complete, a chemical corrosion inhibitor solution, as furnished by the Division 23 Section "Water Treatment," Vendor/Contractor, shall be utilized to initially treat the system.
  9. Clean exterior of piping prior to application of coatings.
- B. Cleanup:
1. Clean coils and plenums.
  2. Clean under, in and around equipment.
  3. Clean exposed surfaces of ducts, piping, and equipment.
  4. Clean equipment cabinets and enclosures.
  5. Provide all new filters for equipment.

**END OF SECTION 23 05 00**

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## SECTION 23 05 23 – GENERAL DUTY VALVES FOR HVAC SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 DEFINITIONS

- A. The following are standard abbreviations for valves:
  - 1. CWP: Cold working pressure
  - 2. EPDM: Ethylene-propylene-diene terpolymer rubber
  - 3. PTFE: Polytetrafluoroethylene plastic
  - 4. SWP: Steam working pressure
  - 5. TFE: Tetrafluoroethylene plastic

#### 1.3 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

#### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for valves up to 125 psig (860 kPa) and ASME B31.1 valves above 125 psig (860 kPa).
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 372 for valve materials for potable-water service.
- D. Source Limitations: Obtain valves of a single type through one source from a single manufacturer.

#### 1.5 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 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 (DN 50) and smaller with threaded or soldered ends.
- C. Ferrous Valves: NPS 2-1/2 (DN 65) and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
  2. Gear Drive: For quarter-turn valves NPS 8 (DN 200) and larger.
  3. Handwheel: For valves other than quarter-turn types.
  4. Lever Handle: For quarter-turn valves NPS 6 (DN 150) and smaller, except plug valves.
  5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Ends:
1. Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
  2. Grooved: AWWAC606.
  3. Solder Joint: With sockets according to ASME B16.18.
    - a. Caution: Use solder with melting point below 840°F (454°C) for angle, check, gate, and globe valves; below 421°F (216°C) for ball valves.
    - b. Threaded: With threads according to ASME B1.20.1.
- I. Valve Bypass and Drain Connections: MSSSP-45

## 2.2 BALL VALVES

### A. Bronze Two-Piece Ball Valves:

#### 1. Manufacturer and Model:

##### a. Threaded Ends:

- 1) Apollo 77C-100 Series
- 2) Hammond 8501
- 3) Nibco T-585-70

##### b. Soldered Ends:

- 1) Apollo 77C-200 Series
- 2) Hammond 8511
- 3) Nibco S-585-70

##### c. Grooved Joint:

- 1) Gruvlok (Anvil) 7500
- 2) Victaulic Series 721

2. 150 psig (1035 kPa) SWP, non-shock 600 psig (2070 kPa) WOG, MSS SP-110, cast bronze, full port, two-piece body design, chrome-plated solid bronze ball with reinforced Teflon seats. Stem packing adjustable for wear with adjusting screw.

### B. Carbon Steel Three Piece Ball Valves:

#### 1. Manufacturer and Model:

##### a. Threaded Ends: Apollo 70-140-64

- 1) Bronze, threaded, 250 psig (1725 kPa) SWP valve with 316 SS ball and stem; multi-fill seats and stuffing box ring; yellow vinyl grip with red lettering; sizes 1/4 inch to 3 inch.

##### b. Socket Weld Ends: Apollo 83-540/640-64 Series

- 1) ASME B16.34, Class 600, end connections; socket-weld per ASME B16.11, valve marking: ASME B16.34.

2. 250 psig (1725 kPa) SWP, non-shock 1500 psig (10350 kPa) WOG, carbon steel, full port, three-piece body design, stem extension, stainless steel ball with Teflon seats, stem packing shall be adjustable for wear with adjusting screw,.

### C. Hose End Valves:

#### 1. Manufacturer and Model:

##### a. Threaded Ends:

- 1) Apollo 70-100HC Series
- 2) Nibco T-585-70-HC



b. Soldered Ends:

- 1) Apollo 70-200HC Series
- 2) Nibco S-585-70-HC

2.3 BUTTERFLY VALVES

A. Flangeless Ferrous Alloy Butterfly Valves:

1. Manufacturer and Model:

- a. Apollo L 141
- b. Centerline 200
- c. Keystone Fig 222
- d. NIBCO LD 2000

2. Flangeless, 200 psig (1380 kPa) CWP Rating through NPS 12 (DNS 300), 150 psig (1035 kPa) CWP Rating NPS 14 (DNS 350) and larger, MSSSP 67, cast or ductile iron body, wafer lug type, extended neck, aluminum bronze or nickel plated ductile iron disc, stainless steel shaft, EPDM seat and seal, 10-position lever locking handle through NPS 6 (DNS 150), worm gear actuator for NPS 8 (DNS 200) and larger valves.

B. Grooved Ferrous Alloy Butterfly Valves:

1. Manufacturer and Model:

- a. Gruvlok (Anvil) 8000GR
- b. Nibco GD4765
- c. Victaulic Series 700/709

2. Grooved, 200 psig (1380 kPa) CWP Rating, MSSSP 67, EPDM or polymer coated cast or ductile iron body, extended neck, aluminum bronze or nickel plated ductile iron disc, stainless steel shaft, EPDM seat and seal, 10-position lever locking handle through NPS 6 (DNS 150), worm gear actuator for NPS 8 (DNS 200) and larger valves.

C. Valves shall be capable for use as isolation valves and be recommended by the manufacturer for dead-end service at the full-rated operating pressure, without the need for downstream blind flanges.

2.4 ECCENTRIC VALVES

A. Balancing Service:

1. Threaded, Class 125:

- a. Milliken MILLCENTRIC
- b. SMG Key Port Valve Fig. 425

2. Flanged, Class 125:

a. Manufacturer and Model:

- 1) DeZurik Fig. 118
- 2) Milliken MILLCENTRIC
- 3) Nibco F737
- 4) Resun

3. Corrosion-resistant, permanently lubricated plug-type or multi-turn hand wheel with suitable seals for intended service, lever or multi-turn operator for valves through 6 inches, worm gear or multi-turn actuator for 8 inches and larger valves, adjustable memory stops all sizes.

## 2.5 GATE VALVES

- A. Flanged, 125 psig (860 kPa) SWP, non-shock 200 psig (1380 kPa) WOG, MSS SP-70-100, Class 125, iron body, bronze trim, solid wedge disc, rising stem, O.S.&Y.

1. Manufacturer and Model:

- a. Apollo 611F
- b. Nibco F-617-O
- c. Milwaukee F2885A
- d. Stockham G612

- B. Flanged, 250 psig (1725 kPa) SWP, non-shock 500 psig (3450 kPa) WOG, MSS SP-70, Class 250, iron body, bronze trim, solid wedge disc, rising stem, O.S.&Y.

1. Manufacturer and Model:

- a. Apollo 621F
- b. Nibco F-667-O
- c. Milwaukee F2894-M

## 2.6 GLOBE VALVES

- A. Threaded, 150 psig (1035 kPa) SWP, non-shock 300 psig (2070 kPa) WOG, MSS SP-80, Class 150, bronze, union bonnet, Teflon disc.

1. Manufacturer and Model:

- a. Apollo 122T
- b. Nibco T-235
- c. Milwaukee 590-T
- d. Stockham B22T

- B. Flanged ends, 125 psig (860 kPa) SWP, non-shock 200 psig (1380 kPa) WOG, MSS SP-85, iron body, bronze trim.

1. Manufacturer and Model:

- a. Apollo 711F
- b. Nibco F-718-N
- c. Milwaukee F-2981
- d. Stockham G512

- C. Threaded end, 300 psig (2070 kPa) SWP, non-shock 600 psig (4140 kPa) WOG, MSS SP-80, Class 300 bronze, union bonnet, Teflon disc.

1. Manufacturer and Model:

- a. Apollo127T
- b. Nibco T275 Y

- c. Milwaukee 572
- d. Stockham B-66

D. Flanged end, 250 psig (1725 kPa) SWP, non-shock 500 psig (3450 kPa) WOG, MSS SP-85, iron body, bronze trim.

1. Manufacturer and Model:

- a. Apollo 721F
- b. Nibco F-768-B
- c. Stockham F-532

## 2.7 SILENT SPRING LOADED CHECK VALVE

A. Wafer type, MSS SP-80, Class 125, bronze or cast iron body, center guided, aluminum bronze disk, EPDM seats, monel or stainless steel springs

1. Manufacturer and Model:

- a. Nibco W910-SS
- b. Metraflex Silent Check
- c. Milwaukee Series 1400
- d. Titan CV-41
- e. Val Matic VM-1400 Series

B. Grooved joint, 300 psig (2070 kPa), Class 150, single disc, spring assisted, bronze or cast iron body, aluminum bronze or stainless steel disc, EPDM seats, monel or stainless steel springs

1. Manufacturer and Model:

- a. Gruvlok 7811
- b. Metraflex CVG 900-BZ
- c. Victaulic Series 716

## 2.8 SWING CHECK VALVES

A. Bronze, 150 psig (1035 kPa) SWP, 300 psig (2070 kPa) non-shock WOG, MSS SP-80, Class 150, renewable bronze disc.

1. Manufacturer and Model:

- a. Threaded:
  - 1) Apollo 164T
  - 2) Nibco T-433B
  - 3) Milwaukee 510-T
  - 4) tockham B-321
- b. Soldered:
  - 1) Apollo 164S
  - 2) Nibco S-433B
  - 3) Milwaukee 1510-T
  - 4) Stockham B-309Y

- B. Flanged, iron body, 125 psig (860 kPa) SWP, 200 psig (1380 kPa) non-shock WOG, MSS SP-71, Class 125, bronze trim.
  - 1. Manufacturer and Model:
    - a. Apollo 910F
    - b. Nibco F-918 B
    - c. Milwaukee F2974A
    - d. Stockham G-931
- C. Grooved, iron body, 125 psig (860 kPa) SWP, 200 psig (1380 kPa) non-shock WOG, MSS SP-71, Class 125, bronze trim.
  - 1. Manufacturer and Model:
    - a. Gruvlok 7811
    - b. Victaulic Series 712
- D. Threaded, bronze, 300 psig (2070 kPa) SWP, 600 psig (4140 kPa) non-shock WOG, MSS SP-80, Class 300, renewable bronze disc.
  - 1. Manufacturer and Model:
    - a. Apollo 168T
    - b. Nibco T-473B
    - c. Milwaukee 507
    - d. Stockham B-375
- E. Flanged, iron body, MSS SP-71, Class 250, bronze trim.
  - 1. Manufacturer and Model:
    - a. Apollo 920 F
    - b. Nibco F-968-B
    - c. Stockham F-947

## 2.9 CHAINWHEEL ACTUATORS

- A. Manufacturers:
  - 1. Babbitt Steam Specialty Co.
  - 2. Roto Hammer Industries, Inc.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. 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.
- F. Do not attempt to repair defective valves; replace with new valves.
- G. Do not install any valve that does not meet the pressure and temperature requirements of the system into which the valve is placed.

### 3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
  - 1. Shutoff Service:
    - a. Water and Glycol:
      - 1) NPS 2 (DN 50) and Smaller: Ball valves.
      - 2) NPS 2-1/2 (DN 65) and Larger: Butterfly valves
    - b. Steam, 15 psig and less:
      - 1) NPS 2 (DN 50) and Smaller: Ball or gate valves.
      - 2) NPS 2-1/2 (DN 65) and Larger: Gate valves
  - B. Heating Water Piping: Use the following types of valves:
    - 1. Ball Valves, NPS 2 (DN 50) and Smaller: Bronze two-piece, threaded or soldered.
    - 2. Butterfly Valves, NPS 2-1/2 (DN 65) and Larger:
      - a. Flangeless, ferrous alloy.
      - b. Grooved ferrous alloy where grooved piping permitted.
    - 3. Check Valves:
      - a. Pump Discharge:
        - 1) NPS 1-1/2 (DN 38) and Smaller: Bronze, Class 150, threaded.
        - 2) NPS 2 (DN 50) and Larger: Wafer, silent spring check valves.
        - 3) Grooved, silent spring check valves where grooved piping permitted.
      - b. Other than pump Discharge: Bronze, Class 150.

4. Balancing Valves:
    - a. NPS 2 (DN 50) and Smaller: Threaded, Class 125.
    - b. NPS 2-1/2 (DN 65) and Larger: Class 125, flanged.
  - C. Steam, 15 psig (104 kPa) and Lower: Use the following types of valves:
    1. Ball Valves, NPS 2 (DN 50) and Smaller: Bronze two-piece, threaded.
    2. Check Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 150, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, flanged Class 125.
    3. Gate Valves NPS 2-1/2 (DN 65) and Larger: Iron body, Class 125, flanged.
    4. Globe Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 150, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, Class 125, flanged.
  - D. Steam, greater than 15 psig (104 kPa) and Higher: Use the following types of valves:
    1. Ball Valves, NPS 2 (DN 50) and Smaller: Carbon steel, three-piece, threaded.
    2. Check Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 300, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, Class 250, flanged.
    3. Gate Valves NPS 2-1/2 (DN 65) and Larger: Iron body, Class 250, flanged.
    4. Globe Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 300, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, Class 250, flanged.
  - E. Steam condensate piping: Use the following types of valves:
    1. Ball Valves, NPS 2 (DN 50) and Smaller: Bronze two-piece, threaded.
    2. Check Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 150, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, flanged Class 125.
    3. Gate Valves NPS 2-1/2 (DN 65) and Larger: Iron body, Class 125, flanged.
    4. Globe Valves:
      - a. NPS 2 (DN 50) and Smaller: Bronze, Class 150, threaded.
      - b. NPS 2-1/2 (DN 65) and Larger: Iron body, Class 125, flanged.
- ### 3.3 VALVE INSTALLATION
- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
  - B. All equipment and materials shall be installed in accordance with the recommendations of the manufacturer.

- C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. All valves shall be installed so they are accessible and serviceable. Install valves in position to allow full stem movement.
- G. All valves shall be installed so the stem position is not more than 90-degrees from the vertical up position.
- H. Install chainwheel operators on valves NPS 4 (DN100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor elevation.
- I. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.
- J. Isolation valves shall be installed:
  - 1. In piping at each and every piece of equipment
  - 2. In piping whenever said pipe enters or leaves an equipment room
  - 3. At all branch take-offs from mains
  - 4. Where shown on drawings
- K. Where butterfly valves are located five pipe diameters or less from an elbow, install the valve with its shaft parallel to the plane of the elbow.
- L. Valve identification requirements are in other Division 23 sections.

### 3.4 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Seats and gaskets shall meet the temperature and pressure requirements of the system in which installed.
- C. Soldered Joints: Use ASTM B813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated

### 3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

**END OF SECTION 23 05 23**

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## SECTION 23 05 25

### VFDs FOR HVAC SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. This Section includes solid-state, PWM, variable frequency drives (VFDs) for speed control of 3-phase, squirrel-cage induction motors for HVAC equipment.
  - 1. All VFDs supplied for this project shall include a bypass starter.

##### 1.03 DEFINITIONS

- A. IGBT: Insulated gate bipolar transistor
- B. LAN: Local area network
- C. PID: Control action, proportional plus integral plus derivative
- D. PWM: Pulse-width modulated
- E. VFD: Variable frequency drive

##### 1.04 SUBMITTALS

- A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFD.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details
    - b. Nameplate legends
    - c. Short-circuit current rating of integrated unit
- C. Wiring Diagrams:
  - 1. Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.
  - 2. Connection diagrams identifying line, load, and external control connection points. Terminal and conductor identification shall correspond to power and control schematics submitted under other sections.
  - 3. Internal wiring diagrams showing internal components and associated interconnections. Drawings shall be sufficiently complete to allow the Engineer to determine compliance with specifications.
  - 4. Network information, point addresses, etc.

- D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
  - E. Qualification Data: For manufacturer and testing agency.
  - F. Field quality-control test reports.
  - G. Certificates: Unit shall be UL or ETL Testing Laboratory listed.
  - H. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include routine maintenance requirements for VFDs and all installed components.
  - I. 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.
  - J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- 1.05 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
  - B. VFDs and options shall be UL508 listed as a complete assembly.
  - C. Contractor Testing Qualifications: Contractor testing specified in Part 3 shall be performed by a qualified individual using a Fluke 43B, or equivalent harmonic quality analyzer.
  - D. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.
  - E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - F. Comply with NFPA 70.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
  - B. If stored in areas subject to weather (allowed only when factory installed in equipment), cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

#### 1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: 0 to 40°C (32°F to 104°F).
  - 2. Humidity: Less than 90% (noncondensing).
  - 3. Altitude: 5300 feet above sea level, derate for project altitude.

#### 1.08 COORDINATION

- 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. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- C. Coordinate installation of disconnects on load side of VFD with electrical contractor. Do not operate VFD without load side disconnect interlocked to VFD control power.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 5 years from date of Substantial Completion.

#### 1.11 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 10% of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than two of each size and type.

### PART 2 – PRODUCTS

#### 2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
  - 2. Siemens
  - 3. Toshiba International Corporation

#### 2.02 VARIABLE FREQUENCY DRIVES

- A. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: Variable torque.
- C. VFD Description:
  - 1. Variable-frequency power converter (rectifier, dc bus, and IGBT, 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 3-phase induction motors by adjusting output voltage and frequency.
2. 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."
  3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. 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.
- E. Drive control shall have an automatically variable carrier frequency of at least 1,000 to 12,000 Hz. There shall be no sudden frequency shifts that cause acoustical noise increases during shifts in the motor speed.
- F. Output Rating: 3-phase; 6 to 66 Hz, with voltage proportional to frequency throughout voltage range.
- G. Unit Operating Requirements:
1. Input ac voltage tolerance, plus or minus 10%.
  2. Input AC Voltage Unbalance: Not exceeding 3%.
  3. Input frequency tolerance of 60 Hz, plus or minus 3%.
  4. Minimum Efficiency: 97% at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 98%.
  6. Overload Capability: 1.1 times the base load current for 60 seconds; 1.8 times the base load current for 3 seconds.
  7. Starting Torque: 100% of rated torque or as indicated.
  8. Speed Regulation: Plus or minus 1%.
  9. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
  10. Ambient Temperature Rating: Not less than 32°F and not exceeding 104°F.
  11. Ambient Storage Temperature Rating: Not less than minus 4°F and not exceeding 140°F.
  12. Humidity Rating: Less than 95% (noncondensing).
  13. Altitude Rating: Derated for site elevation.
- H. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25% of maximum rpm
  2. Maximum Speed: 80 to 110% of maximum rpm
  3. Acceleration: 2 to a minimum of 22 seconds
  4. Deceleration: 2 to a minimum of 22 seconds
  5. Current Limit: 50 to a minimum of 110% of maximum rating
  6. Operating Frequency Lockout: 3 frequency bands
- J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide 3-phase protection against damage from supply voltage surges 10% 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 three 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 over temperature fault.
- K. 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.
- L. 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.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Integral Disconnecting Means and Overcurrent Protection Device: NEMA KS 1, fusible switch with pad lockable, door-mounted handle to protect VFD circuit and bypass circuit.
1. Disconnect Rating without by-pass: Not less than 115% of VFD input current rating.
  2. Disconnect Rating with by-pass: Not less than 115% of NFFPA 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.
- 2.03 CONTROLS AND INDICATION
- A. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed backlit 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.
  3. Display shall indicate the following controller parameters:
    - a. Output frequency (Hz)
    - b. Motor speed (rpm)
    - c. Motor status (running, stop, fault)
    - d. Motor current (amperes)
    - e. Motor torque (percent)
    - f. Fault or alarming status
    - g. PID feedback signal (percent)
    - h. DC-link voltage (V dc)
    - i. Set-point frequency (Hz)
    - j. Motor output voltage (V ac)
- B. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
  2. Running log of total power versus time.
  3. Total run time.
  4. Fault log, maintaining last four faults with time and date stamp for each.

- C. Control Signal Interface:
  - 1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs: (0 to 10V or 0-20 mA or 4-20 mA).
    - b. A minimum of six multifunction programmable digital inputs.
  - 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the control systems:
    - a. 0 to 10V dc
    - b. 0-20 mA or 4-20 mA
    - c. Potentiometer using up/down digital inputs
    - d. Fixed frequencies using digital inputs
  - 3. Output Signal Interface: A minimum of 1 analog output signal (0-20 or 4-20 mA) that can be programmed to 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)
  - 4. Remote Indication Interface: A minimum of two programmable dry circuit relay outputs (120V ac, 1A) 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
- D. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
  - 1. Number of Loops: One

- E. Variable Frequency Drive Control Network Requirements: Coordinate with Section 230913, “Instrumentation and Controls for HVAC,” to assure compatibility of the network protocol and physical media. Provide the needed interfaces, to communicate directly on the control LAN using a native standard protocol which matches the protocol used by the control supplier, either BACnet (ANSI/ASHRAE 135-2010) or LonTalk (ANSI/EIA-709.1B). BACnet devices shall be BTL listed under a device profile B-ASC. LonTalk shall have LonMark certification. BACnet applications shall support BACnet IP over Ethernet and MSTP. Fully cooperate with Section 230913 who will be acting as the Systems Integrator, to assure that the systems are compatible, communicating effectively and at an acceptable speed. The VFD shall communicate the following data over the building control network (LAN).

Object Type	Sequential Number	Generic Data Name	VFD Data Name (varies by manufacturer)
BI	1	Drive Run Status	Run/Stop ACT
BI	2	Drive Fault Status	Fault ACT
BI	3	Hand/Auto	Hand/Auto
BI	4	Alarm ACT	Alarm ACT
BI	5	Maint Req	Maintenance Status
BI	6	Drive at set point	At Set point
BO	7	Start/Stop	Run/Stop CMD
BO	8	Fault Reset	Fault Reset
AO	9	Speed	Analog input 1
AI	10	Run time	Run Time (R)
AI	11	Current	Current
AI	12	Speed	Speed
AI	13	Frequency Output	
AI	14	Power	Power (kW)
AI	15	KWH Counter	KWH
AI	16	Last Drive Fault	

2.04 LINE CONDITIONING AND FILTERING

- A. Comply with IEEE 519 - 1992. Provide VFD input filtering to limit current distortion ( $I_{TDD}$ ) and voltage distortion ( $V_{THD}$ ) to specified levels at the indicated points of common coupling (PCC) to specified levels. Refer to the Division 26 drawings for the PCC table listing the PCCs and respective fault duty and demand load.
- B. Based on the harmonic analysis study and report, provide harmonic mitigation assemblies, to limit current distortion ( $I_{TDD}$ ) and voltage distortion ( $V_{THD}$ ) at the points of common coupling to less than the prescribed thresholds.
- C. If harmonic mitigation is required to meet these requirements, the VFD manufacturer shall provide the harmonic mitigation assemblies and is responsible for their design and manufacture. Test as described in Part 3 to confirm harmonic performance criteria.
- D. Limit voltage distortion ( $V_{THD}$ ) to 5%.
- E. Limit the total demand current distortion ( $I_{TDD}$ ) and the current distortion in each individual harmonic order to that prescribed in IEEE-519 according to the ISC/IL ratios on the PCC data.

1992 IEEE 519 Standard Current Distortion Limits Maximum Harmonic Current Distortion in Percent of $I_L$						
$I_{sc}/I_L$	Individual Harmonic Order					$I_{TDD}$
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 < h$	
$< 20$	4	2	1.5	0.6	0.3	5
$20 < 50$	7	3.5	2.5	1	0.5	8
$50 < 100$	10	4.5	4	1.5	0.7	12
$100 < 1000$	12	5.5	5	2	1	15
$> 1000$	15	7	6	2.5	1.4	20

2.05 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.
  - 1. Bypass Contactor: Load-break, contactor.
  - 2. Output Isolating Contactor: Non-load-break, 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.
- D. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
1. Power on
  2. Run enable
  3. Drive mode selected
  4. Bypass mode selected
  5. Drive running
  6. Bypass running
  7. Drive fault
  8. Bypass fault
  9. Bypass H-O-A mode
  10. Automatic transfer to bypass selected
  11. Safety open
  12. Damper opening
  13. Damper end-switch made
- E. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
1. NORMAL/BYPASS selector switch.
  2. HAND/OFF/AUTO selector switch.
  3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
  4. 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.
  5. Control Circuits: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with control power transformer of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices. Transformer shall have 50 VA spare capacity.
  6. Overload Relays: NEMA ICS 2.
    - a. Solid-State Overload Relays:
      - 1) Switch or dial selectable for motor-running overload protection.
      - 2) Sensors in each phase.
      - 3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- 2.06 ENCLOSURES
- A. VFD Enclosures: NEMA 250 completely assembled and tested by the manufacturer in an ISO9001 facility, to comply with environmental conditions at installed location:
1. UL Type 1 (NEMA 1): suitable for most commercial interior locations
- 2.07 FACTORY FINISHES
- A. Finish: Manufacturer's standard finish applied to factory-assembled VFDs.

## 2.08 REQUIRED OPTIONS

### A. HVAC Control Features:

1. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, BAS control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close.

## 2.09 SOURCE QUALITY CONTROL

### A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
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

### 3.01 EXAMINATION

#### A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, 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.

### 3.02 APPLICATION

#### A. Provide VFDs where scheduled on drawings.

#### B. Provide manual bypasses on VFDs where scheduled on drawings.

### 3.03 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.

#### C. The drives shall be installed, wired, tested, and calibrated per the manufacturer's recommendations.

- D. Comply with mounting and anchoring requirements specified in Division 23 Section "Hangers and Supports for HVAC Systems" and Division 23 Section "Wind and Vibration Controls for HVAC."
- E. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26."
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26.
- G. Comply with NECA 1.

### 3.04 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Division 23 Section "Common Requirements for HVAC Systems."

### 3.05 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
  - 1. Inspect drives, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state drives and participate in the commissioning process.
  - 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
  - 1. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
  - 2. Test continuity of each circuit.
  - 3. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
  - 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 5. Solid-state components shall be load-tested to ensure correct function and highest reliability. Provide "signed off" checklist.
  - 6. Every controller will be functionally tested under designed motor load for at least two hours with written certification to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.
  - 7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  - 8. Network Controls: Verify communications wiring and test bi-directional communications of all specified point data.
- D. VFDs will be considered defective if they do not pass tests and inspections.
- E. 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.

3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform. Complete installation and startup checks according to manufacturer's written instructions.

3.07 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 and circuit-breaker trip ranges.

3.08 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.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency drives. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION**

## SECTION 23 05 29 – HANGERS AND SUPPORTS FOR MECHANICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: The contractor shall design trapeze pipe hangers and equipment supports, using performance requirements and design criteria indicated. Trapeze hangars and equipment supports may be designed using recognized, catalogued, pre-engineered methods. Follow all means and methods identified on the support system product data.
- B. Hangers and supports for equipment and distribution systems shall withstand the effects of gravity loads and stresses within limits and under conditions indicated.
  - 1. Supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.4 SUBMITTALS

- A. Product Data: Provide sufficient information to show the hangars and supports are suitable for the intended purpose, including design loads and actual loads. Provide submittal data for:
  - 1. Mechanical systems and equipment hangers and supports
  - 2. Thermal-hanger shield inserts
  - 3. Devices for attachment to the structure
  - 4. Recognized, catalogued, pre-engineered hangar and support systems.
- B. Seismic Control Data: Submit all required information by the Delegated Design Professional in responsible charge of design for Seismic Controls for this project. Where specification section 23 05 48 "Wind, Seismic, and Vibration Controls for Mechanical Systems" does not indicate any required seismic controls, no such submittal is required.
- C. Shop Drawings: Provide fabrication and installation details, calculations stamped by a Registered Professional Engineer, and Product Data for the following systems:
  - 1. Trapeze pipe, duct hangers, multi-trade support racks, and equipment supports not addressed by recognized, catalogued, pre-engineered methods.
  - 2. Architect/Engineer Responsibilities: The Architect/Engineer shall review delegated design submittals for compliance with specification requirements. Design and analysis performed for the delegated design submittal will not be reviewed.

- D. Certification: Welders' Certificates.

## 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code.

## PART 2 - PRODUCTS

### 2.1 PIPE HANGERS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
  - 1. Anvil International
  - 2. B-Line Systems, Inc.; a division of Cooper Industries
  - 3. nVent Caddy
  - 4. PHD Manufacturing, Inc.
  - 5. Tolco/Eaton
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
- F. Specially designed hanger systems meeting or exceeding the performance of the above products may be submitted for review by the Engineer. Provide adequate performance data with submittal. Above specified products shall be used if found not equivalent by the Engineer.

### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

### 2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
  - 1. B-Line Systems, Inc.; a division of Cooper Industries
  - 2. nVent Caddy
  - 3. PHD Manufacturing, Inc
  - 4. Power-Strut Div.; Tyco International, Ltd.
  - 5. Tolco/Eaton
  - 6. Unistrut Corp.; Tyco International, Ltd.

#### 2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig (690 kPa) minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
  - 1. Carpenter & Paterson, Inc.
  - 2. ERICO/Michigan Hanger Co.
  - 3. PHS Industries, Inc.
  - 4. Pipe Shields, Inc.
  - 5. Rilco Manufacturing Company, Inc.
  - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.
- H. Specially designed thermal hanger systems meeting or exceeding the performance of the above products may be submitted for review by the Engineer. Provide adequate performance data with submittal. Above specified products shall be used if found not equivalent by the Engineer.

#### 2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head
    - c. Masterset Fastening Systems, Inc.
    - d. MKT Fastening, LLC
    - e. Powers Fasteners
    - f. PHD Manufacturing, Inc.

#### 2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

#### 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
  - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

### PART 3 - EXECUTION

#### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 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.

#### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-58 and MSS SP-89 for the installation of hangers, supports, clamps, and attachments to properly support piping from building structure.
- B. Hanger Spacing:
  - 1. Hanger spacing and sizing shall per MSS SP-58 or applicable codes, whichever is more stringent.
  - 2. Hanger spacing must be reduced to compensate for any valves and/or fittings installed in the pipe run.
  - 3. Alternate span calculations may be used with a maximum deflection of 0.1 inch (2.5 mm) between hangers.
  - 4. Hanger spacing must be reduced if thermal hanger shield insert cannot support full span.
- C. Channel Support or Steel Trapeze System Installation:
  - 1. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
  - 2. Multiple pipe runs may be supported on channel/steel trapeze support systems with rollers. Support systems shall be individually designed by a structural engineer with the exception of the following:
    - a. For pipe configurations specified in Table 1, channel support system hangers shall be as described below. Channel support shall be Unistrut P-1000. Hanger rods shall be one size larger than MSS SP-58 requires for largest pipe on support. Where support length exceeds 42 inches (1050 mm), additional hanger rod shall be installed at mid-span and pipe quantities in Table 1 may be placed on each side. Rollers shall be Unistrut P2474 through 6 inches, or P2475 through 16 inches; equal by Anvil or B-Line. Maximum number of pipes on one 42-inch (1050 mm) P-1000 channel support is:



Table 1	
Largest Pipe Size	Maximum No. Pipes
NPS 5 (DN125) and larger	0
NPS 4 (DN100)	2
NPS 3 (DN75)	3
NPS 2-1/2 (DN65)	5
NPS 2 (DN50)	8
NPS 1-1/2 (DN40)	12
NPS 1-1/4 (DN32) and smaller	16

D. Hanger and Support Installation:

1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
2. 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.
3. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
4. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31 is not exceeded.
5. Comply with the following for insulated piping:
  - a. Attach clamps and spacers to piping.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Generator exhaust piping: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - d. Do not exceed pipe stress limits according to ASME B31.1.
  - e. Provide protection shields at all pipe supports. Metal shield lengths shall be as required by MSS-SP58 for the compressive strength and support span. Manufactured units shall include certification of compliance with MSS-SP58 for intended use. Requirements shall be as follows:
    - 1) Insulated piping up to NPS 1-1/2 (DN40) - MSS Type 40 insulation protection shields without high-density inserts.
    - 2) Insulated piping NPS 2 (DN50) and larger - MSS Type 40 thermal-hanger shield assemblies with the high-density inserts having the same thickness as piping insulation.

E. Building Attachments:

1. Review structural drawings for details of methods of attachment. Coordinate support requirements with project structural engineer.
2. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length specified herein or as indicated in MSS SP 58. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
3. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
4. Attachments to bar joists shall be at panel points and shall comply with load limits and other requirements of the Structural Engineer.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Connections shall be welded.

### 3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
  - 1. Non-flat paints and coatings used within buildings shall have a VOC content of 150 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Low-Emitting Materials: Interior paints and coatings 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."
- B. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (.05 mm).
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.3.1.
  - 1. Galvanizing repair paints and coatings used within buildings shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Low-Emitting Materials: Interior paints and coatings 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."

**END OF SECTION 23 05 29**

## SECTION 23 05 93 – 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 Specifications, apply to this Section.

#### 1.2 SUBMITTALS

- A. Samples: Submit proposed test and balance forms and report formats at least 120 days prior to commencing field work.

- B. Quality Assurance/Control Submittals: Qualifications - Within 30 days after contract award, submit the name(s) of the professional engineer and/or the NEBB or AABC certified supervisor who will be supervising this work. Submit the name(s) of the test and balance technician(s) who will be performing the work.

- C. Close-out Submittals:

- 1. Test and Balance Report: After all balancing is complete, and all coordination with the Commissioning Agent and the Owner or his representative is complete, the balancing firm shall furnish four bound reports that shall contain the test data information as detailed in Part 3 and as follows:
  - a. Results of dynamic balance testing:
    - 1) Baseline amplitude, velocity, and acceleration frequency spectrum printouts for all devices.
    - 2) All test values exceeding manufacturer's standards shall be identified with recommendations for corrective action.
    - 3) Retest results for rejected devices after corrective action.
  - b. A reduced set of drawings (11" x 17") (275 mm x 425 mm) shall be included in the report with all terminals (VAV boxes, air outlets, inlets, coils, unit heaters, fin tube loops, radiant panel loops, etc.) clearly marked, all equipment designated, and all referenced to the device test reports. The contract drawings may be reduced and used for this purpose, if they remain legible.
  - c. The test and balance Contractor shall submit bound copies of the final testing and balancing report to the Owner or his representative at least 15 days prior to the Mechanical Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as required in Part 3, a list of all equipment used in the testing and balancing work, and shall be signed by the supervising registered engineer or certified test and balance supervisor and certified test and balance technician, and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.
- 2. Balance report shall not be submitted until all improperly configured or installed systems are corrected and improperly installed or missing balance devices are corrected and tested reports submitted with incomplete information will be returned unreviewed.

### 1.3 QUALITY ASSURANCE

#### A. Qualifications:

1. Pre-qualified test and balance and sound and vibration testing firms for this project are:
  - a. Elite Balance 720-523-0209
  - b. Finn & Associates 303-353-8210
  - c. Fort Collins Midwest, Inc. 970-223-5421
  - d. Griffith Engineering 303-688-5054
  - e. Jedi Balancing 720-839-5333
  - f. JPG Engineering 303-688-9044
  - g. Rocky Mountain Balance 303-623-7648
  - h. Tab Services 303-649-1213
  - i. United Test & Balance 720-333-3601
  - j. West Electronic Balancing 303-934-5529
  - k. ABS 303-458-1742
2. Other qualified firms desiring to furnish services for this project shall submit for written approval, during bid time, a brochure listing the qualifications of personnel in the organization, instruments available to be used, an outline of system balancing procedures that is intended to be followed, and a list of projects successfully balanced within the last two years. Information regarding additional qualifications listed below must be in the office of the Engineer at least 14 calendar days prior to the date set for receiving bids.
3. The balancing work, including air and hydronic portions, shall be performed by the same firm having total professional responsibility for the final testing, adjusting, and balancing of the entire system. The test and balance firm shall not be associated with the Commissioning Agent.
4. Test and balance firm shall:
  - a. Have had previous experience with at least one project of similar type and size in the State of Colorado. Provide the project(s) name, owner, general contractor, mechanical contractor, and references with phone numbers for each.
  - b. Have a permanent place of business and phone number within a 200-mile (320 km) radius of the job site.
  - c. Have been actively engaged in balancing work within the State of Colorado for at least three of the past five years. Provide at least three project references with phone numbers.
  - d. Have a minimum of two permanent employees who have been actively engaged in balancing work for a minimum of 3 years. Provide names, certifications, and experience resumes.
5. The test and balance field work shall be performed under the direct supervision a NEBB or AABC certified test and balance supervisor. The certified supervisor shall:
  - a. Perform the test and balance work or be on-site at least 33% of the total time the test and balance work is in progress, or
  - b. Be on site a minimum of 10% of the total time the test and balance work is in progress with the work performed by a full-time certified NEBB or AABC test and balance technician.
6. The vibration testing firm shall be an independent test and balance firm or vibration testing firm, not associated with equipment suppliers or installers, specializing in dynamic vibration measurement and balance. The agency shall be NEBB or AABC certified in sound and vibration testing and shall have been actively engaged in vibration testing and balancing work for a minimum of three years. Firms not certified by NEBB or AABC shall have been actively engaged in sound and vibration testing work for a minimum of five years and shall provide three references including project name, owner, general contractor, mechanical contractor, and references with phone numbers for each.

B. Certifications:

1. Testing, adjusting, and balancing shall be done by a firm using NEBB or AABC certified supervisors, or by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with the contractor performing work under Division 23; the firm derives its income solely from testing, adjusting, and balancing and/or commissioning mechanical systems; and the work is performed in a professional manner.
2. Test and balance firm shall own or rent and have available for this project all necessary balancing instruments as required to maintain NEBB or AABC certification. Instrument calibration shall have been checked and verified as per NEBB AABC requirements. Provide instrument list with calibration date for each instrument listed.

C. Regulatory Requirements:

1. Refer to Division 23 Section "Common Work Results for HVAC," for general code, standard and regulatory requirements.
2. Comply with procedural standards for testing, adjusting, and balancing of environmental systems as outlined in the latest edition of SMACNA, NEBB, and/or AABC procedural manuals.
3. ASHRAE Compliance:
  - a. Applicable sections and paragraphs as published in ASHRAE 2011 Applications Handbook, Chapter 38, Testing, Adjusting, and Balancing, and Standard 111.
  - b. Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
4. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007-, Section 6.7.2.3 - "System Balancing."

1.4 SCHEDULING

A. Coordinate scheduling of work with the General Contractor, the appropriate subcontractors.

1. Schedule test and balance work to coincide with testing and verification of control systems where practical.
2. Coordinate system startup and performance verification with the Commissioning Agent as test and balance work is in progress.

B. Provide written notification (within 24 hours) to General Contractor, Commissioning Agent, Engineer, and Owner or his representative of any component and/or system deficiencies.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Provide all necessary tools, scaffolding, and ladders.
- B. Provide all necessary instruments. Calibration and maintenance of instruments shall be in accordance with NEBB or AABC. Calibration histories for each instrument shall be available for examination.
- C. When DDC terminal unit controls are used, appropriate temperature control application software and hardware shall be used for proper interface with the terminal unit DDC controls.
- D. Provide all sheaves necessary to obtain design airflow from fans.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Air and water testing and balancing shall not begin until the system to be tested has been cleaned and flushed, and is in full working order. Where glycol is used, it shall be installed prior to hydronic balancing.
- B. Preliminary test and balance requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, visual observations at the site during construction shall have been made to determine the location of required balancing devices; that they are being installed properly; and that proper access has been provided.
- C. Prior to and during testing and balancing, the testing and balancing technician shall immediately notify the Contractor of all balancing devices not yet installed and those portions of the system unable to be balanced. The Contractor shall correct the deficiencies and shall notify the Engineer of situations requiring additional instruction.
- D. Before any air balance work is done, the system shall be checked for:
  - 1. Excessive duct, plenum, and equipment leakage
  - 2. Dirt and debris in ducts and/or AHUs
  - 3. Filters are installed (and changed if they are dirty)
  - 4. Coil fins are clean and combed where needed
  - 5. Correct motor rotation
  - 6. Excessive vibration
  - 7. Equipment lubrication
  - 8. Proper operation of automatic control and smoke dampers
  - 9. Manual control dampers, fire dampers, and air outlet dampers are wide open
  - 10. Duct end caps installed and access doors closed
  - 11. Grilles, registers, and diffusers are properly installed
  - 12. Underfloor plenum leakage
  - 13. Building leakage testing is complete
- E. Before any hydronic balancing work is done, the system shall be checked for:
  - 1. Proper cleaning and flushing; glycol installed when specified
  - 2. Dirty strainers
  - 3. Correct pump rotation
  - 4. Proper control valve installation and operation
  - 5. Proper system static pressure to assure a completely filled system
  - 6. Air in system eliminated
  - 7. Proper flow meter and check valve installation
  - 8. Manual balancing devices, control and shut-off valves are open at this time.
- F. Put heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing.

### 3.2 REQUIREMENTS OF WORK

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

- 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, install test ports and duct access doors that comply with requirements in Division 23 Section "Ducts and Accessories."
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "Mechanical 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 (IP) and metric (SI) units.
- E. All equipment, provide the following included with the equipment test data. Underlined items require other equipment test data sections be included within specified test data section:

<b>Electric Motor, Drive, VFD Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
<b>Motor</b>			
Motor HP	X	X	
Motor type (ODP, TEFC, etc.)	X	X	
Motor RPM	X	X	X
Voltage per phase	X	X	X
Motor amperage per phase	X	X	X
Motor service factor	X	X	
Motor efficiency class (EPACT, NEMA Premium, etc.)	X	X	
<b>Belt Drive</b>			
Motor sheave OD (Belt Drive)		X	X
Fan sheave ID (Belt Drive)		X	X
Sheave centerline distance (Belt Drive)			
Number/size belts (Belt Drive)		X	X
Driven RPM Initial (Fan, etc.)			X
Driven RPM Final (Fan, etc.)			X
<b>Motor Starter</b>			
Manufacturer	X	X	
Model	X	X	
Size	X	X	
Overload <span style="float: right;">size/</span> Electronic overload set point	X	X	
Trip class set point	X	X	
<b>VFD</b>			
Manufacturer	X	X	
Model	X	X	
Main fuse size	X	X	
VFD fuse size	X	X	

<b>Electric Motor, Drive, VFD Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Bypass fuse size (when equipped)	X	X	
Maximum frequency set point			X
Minimum frequency set point			X
Final frequency set point			X
Resonant/vibration frequency lock-out bands			X

F. Air Balance, provide the following:

<b>Air Handling Unit Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Manufacturer	X	X	
Model number	X	X	
Total supply airflow	X		X
Return airflow	X		X
Outside airflow (all modes); confirm accuracy of min OSA controller if installed	X		X
Total design outlet airflow	X		X
Total SP	X		X
External SP	X		X
Internal SP	X		
Static pressure across all elements			X
Fan discharge SP			X
Fan Suction SP			X
AHU discharge SP			X
AHU return SP			X
Supply air temperature**			X
Return air temperature**			X
Mixed air temperature**			X
Outside air temperature**			X
Mixed Air Temperature**			X
Include Motor, Drive, VFD Test Data*			
Include Coil Test Data			

\* VFD may be used to balance belt drive fans +/- 10%.

\*\* Provide when requested by Engineer.



<b>Fan Test Data (125 W or 1/6 hp and larger)</b>			
<b>Item*</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Type of Service	X		
Manufacturer	X	X	
Model number	X	X	
Total airflow	X		X
External SP	X		X
Fan discharge SP			X
Fan Suction SP			X
Include Motor, Drive, VFD Test Data*			

\*VFD may be used to balance fans +/- 10%.

<b>Fan Test Data (less than 125 W or 1/6 hp)</b>			
<b>Item*</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
System designation	X		
Outlet Number	X		
Manufacturer	X	X	
Total airflow	X		X

\* Motor, Drive, VFD Test Data not required.

\*Include connected grille, register, and diffuser data for each VAV address.

G. Hydronic Balance, provide the following:

<b>Hydronic Pump Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Type of Service	X		
Manufacturer	X	X	
Model number/size	X	X	
Impeller size	X	X	
Static pressure			X
Regulator/feed tank fill pressure	X		X
Expansion tank charge pressure	X		X
Wide open flow			X
Wide open discharge head			X
Wide open suction head			X

<b>Hydronic Pump Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Final flow			X
Final discharge head			X
Final suction head			X
No flow suction head			X
No flow discharge head			X
Include Motor, Drive, VFD Test Data*			

<b>Hydronic Balancing Valve Test Data, Manual</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Type of Service	X		
Manufacturer	X	X	
Model number	X	X	
Size	X	X	
Flow	X		X
ΔP			X
Dial setting			X

<b>Hydronic Balancing Valve Test Data, Self-Adjusting</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Type of service	X		
Manufacturer	X	X	
Model number	X	X	
Size	X	X	
Flow	X		X
Operating pressure range	X	X	
ΔP			X

<b>Ultrasonic Flow Measurement Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Reading designation	X		
Type of service	X		
Location	X		
Flow	X		X
Pipe size	X	X	
Pipe material	X	X	
Wall thickness	X	X	
Transducer size			X
Transducer spacing			X
Instrument used for testing			X

<b>Steam-to-Water Heat Exchanger Test Data</b>			
<b>Item*</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Manufacturer	X	X	
Model number	X	X	
Serial number		X	
Service	X		
Steam main pressure*	X		X
Heat exchanger steam pressure*	X		X
Secondary water flow ΔP	X		X
Secondary water ΔP	X		X
Secondary entering water temperature*	X		X
Secondary leaving water temperature*	X		X

\* Provide at request of Engineer.

<b>Unit Heaters, Fin Tube, Fan Coils, Other Terminal Units</b>			
<b>Item (Complete where applicable)</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Unit designation	X		
Unit type	X		
Location	X		
Include Coil Test Data			
Include Motor, Drive, VFD Test Data			

<b>Hydronic Heating Coil Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Coil designation	X		
System served	X		
Coil location	X		
Design coil water flow	X		
Design waterside ΔP	X		
Design airflow	X		
Design airside ΔP	X		
Initial coil water flow			X
Initial waterside ΔP			X
Initial airflow			X
Initial airside ΔP			X
Final coil water flow			X
Final bypass water flow (3-way valves)			X

<b>Hydronic Heating Coil Test Data</b>			
<b>Item</b>	<b>Tabulate Design/Submittal Data</b>	<b>Confirm Actual Installation</b>	<b>Test</b>
Final waterside ΔP			X
Balance valve reading (Valves with scale)			
Final airflow			X
Final airside ΔP			X
Entering dry bulb temperature*	X		X
Leaving dry bulb temperature*	X		X
Entering water temperature*	X		X
Leaving water temperature*	X		X
Balance Valve Test Data			

\* Provide at request of Engineer.

H. Adjust hydronic systems to the following tolerances:

1. Heating System:

- a. Supply water temperature 120°F to 160°F (49°C to 71°C): -5% to +10% of design value.
- b. Supply water temperature above 160°F (71°C): -10% to +10% of design value.

I. Hydronic Balance:

- 1. Variable volume hydronic systems without flow measuring devices: Open pump balance valve and all system balance valves, if equipped to wide open flow. With all control valves open, measure pump flow, head, and motor amperes. If motor amperes are above nameplate, reduce VFD maximum speed set point to bring amperes within nameplate. If flow is below design, increase VFD speed above nameplate motor speed to increase flow without exceeding nameplate amperes.
- 2. Variable volume hydronic systems with flow measuring devices: Open pump balance valve and all system balance valves, if equipped to wide open flow. With all control valves open, measure pump flow, head, and motor amperes. If motor amperes are above nameplate, reduce VFD maximum speed set point to bring amperes within nameplate. If flow is below design, increase VFD speed above nameplate motor speed to increase flow without exceeding nameplate amperes. Systems/ devices shall be balanced proportionally using the flow measuring devices. Repeat pump adjustment procedure.
- 3. When all hydronic balancing is done, all balancing valve positions shall be marked and the locking devices set. Control valve bypass loops (where used) shall be set with the balancing valve to provide equal flow in either mode. Confirm in report.

J. Dynamic Balance Testing:

1. Qualifications:

- a. Balance tester shall have been performing vibration testing and analysis of HVAC and mechanical equipment for a minimum of three years. Provide proof of experience and a minimum of three references with phone numbers.
- b. Testing firm shall utilize an IRD 880 or better microprocessor-based frequency spectrum analyzer. Submit specifications and calibration history of instruments to be used for vibration analysis and alignment testing.

2. All measurements and tests required in this section shall be performed with system fluid (liquid or air) temperatures and pressures in normal operating range, and with room ambient temperatures between 60°F to 90°F (16°C to 32°C) and/or outdoor ambient temperatures between 35°F to 85°F (2°C to 29°C).
  - a. All rotating equipment 1 hp (0.75 kW) and above shall be tested per this section, including both motors and driven equipment.
3. Mounting and Alignment:
  - a. Check rotating equipment for proper mounting and isolation per job specifications and manufacturer's recommendations.
  - b. Verify that any field-supplied shims used for alignment purposes are of stainless-steel type shim stock; mild steel is not acceptable.
  - c. Check alignment of rotating couplings using "reverse dial" methods. Runout and/or misalignment shall be measured and checked against ISO Standards and manufacturer's recommendations; however, total indicated runout shall not exceed 2 mils (0.05 mm) maximum in any case.
  - d. Any measured values beyond recommended maximums shall be reported immediately for corrective action.
- K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

### 3.3 FIELD QUALITY CONTROL

- A. Upon request of the Commissioning Agent Engineer, a representative of the balancing firm performing the work shall demonstrate fluid flow quantities shown in the report by reading back outlets or terminals selected at random by the Engineer. It is understood that the operating mode of the system shall be the same for read back as it was during balancing, and the number of readings verified will not exceed 10% of the total in the report. If rechecks fail, test and balance report will be rejected.
- B. Equipment non-performance not resolvable by the Contractor and Commissioning Agent shall be reported to the Engineer. Balancer shall assist the Engineer, when requested, by providing field temperature, pressure and flow information at specific locations.
- C. When deemed necessary by the Owner or Engineer, the balancing firm shall run temperature, pressure, and/or humidity recordings, and shall be prepared to verify any of the report test results in the presence of the Owner and/or Engineer.
- D. When deemed necessary by the Engineer, a 24-hour space temperature recording shall be taken and any required partial rebalance of the system shall be performed without any additional cost.

**END OF SECTION 23 05 93**

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## SECTION 23 07 00 – MECHANICAL INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 DEFINITIONS

- A. The word "concealed" as used in this section refers to insulation in ceiling plenums, furred spaces, pipe and duct shafts, unheated spaces immediately below roof and crawl spaces. The word "exposed" refers to insulation in other areas.

#### 1.3 SYSTEM DESCRIPTION

- A. Systems to be Insulated: Insulate portions of the following systems, equipment, and accessories, except where noted otherwise or furnished by OEM as part of equipment.

- 1. Hot Piping Systems:

- a. HVAC heating water piping
- b. Steam and steam condensate lines
- c. Piping inside unit ventilators, air handling units, unitary air conditioning units, and terminal heating and cooling units
- d. Fittings, valves, strainers, and check valves

- 2. Items that need not be insulated:

- a. Piping within baseboard (fin tube) radiation enclosures
- b. Factory pre-insulated equipment

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, permeability, thickness, and jackets (both factory and field applied, if any). Submit a schedule showing on one document, each mechanical system or component to be insulated, and the product to be used on each system/component.

- B. Shop Drawings:

- 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger
- 2. Detail insulation application at pipe expansion joints for each type of insulation
- 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation
- 4. Detail removable insulation at piping specialties, equipment connections, and access panels
- 5. Detail application of field-applied jackets
- 6. Detail application at linkages of control devices
- 7. Detail field application for each equipment type

- C. Field quality-control reports.



## 1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Protect insulation against dirt, water, chemical, or mechanical damage before, during, and after installation. Satisfactorily repair or replace any such insulation or covering damaged prior to final acceptance of the work.
- B. 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 size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

## 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 PIPE INSULATION

- A. Manufacturers:
  - 1. Armstrong World Industries
  - 2. Certainteed Crimpwrap
  - 3. Fibrex Insulations Inc.; Coreplus 1200
  - 4. Knauf Insulation; 1000 Pipe Insulation
  - 5. Manson Insulation Inc.; Alley-K
  - 6. Owens Corning; Fiberglas Pipe Insulation
  - 7. Johns Manville; Micro-Lok

- B. Preformed fiberglass conforming to ASHRAE 90.1-2004, ASTM C547, Class I or II, and ASTM C585 with "K" factor of 0.23 Btu-in./h-sf-°F (0.033 W/m-°K) maximum at 75°F (24°C) mean temperature. See schedule for thickness.
- C. Provide factory-applied ASJ/SSL type, ASTM C921, or ASTM C1136, Type I jacket with vapor barrier for cold piping (below ambient), or Type II for hot piping (above ambient). Type I may be used for both at Contractor's option. Factory-applied flap adhesive (SSL) or conventional staple and tape seal at Contractor's option.
- D. Pipe Insulation Thickness Schedule:

Piping System Type	Minimum Insulation Thickness for Pipe Sizes					
	From:	NPS 1 (25 mm)	NPS 1-1/2 (40 mm)	NPS 4 (100 mm)	NPS 8 (200 mm)	Greater than NPS 8 (DN 200)
	To less than:	NPS 1 (DN 25)	NPS 1-1/2 (DN 40)	NPS 4 (DN 100)	NPS 8 (DN 200)	
1. Heating hot water supply and return up to 200°F (93°C)		1-1/2" (40 mm)	1-1/2" (40 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
2. Steam and condensate return 15 psi (104 kPa) or less		2-1/2" (65 mm)	2-1/2" (65 mm)	2-1/2" (75 mm)	3" (75 mm)	3" (75 mm)
3. Steam and condensate up to 100 psi (670 kPa)		3" (75 mm)	4" (100 mm)	4-1/2" (115 mm)	4-1/2" (115 mm)	4-1/2" (115 mm)

Note: For piping exposed to outdoor ambient temperatures, increase thickness by 0.5 in (13 mm).

- E. Cover fittings and valves with pre-molded one-piece PVC-insulated covers. This product is not to be installed in locations where its use is prohibited by local codes.
- F. Protect insulation on exterior piping exposed to the weather with weatherproof metal jacket. Provide jacket with 0.016-inch-thick (0.41-mm thick) aluminum, with laminated vapor barrier. Provide "Z" groove in jacket to assure watertight seal. Seal each joint with snap straps containing permanently plastic sealing compound and secured by 1/2-inch-wide (13-mm-wide) stainless steel bands.
- G. Protect insulation on exterior piping exposed to the weather with a weatherproof and durable Hypalon rubber-coated fiberglass fabric jacket. Provide jacket with laminated Mylar vapor barrier. Washable and paintable jacket, non-corrosive, UL Class 1, asbestos free, 10.5 oz. per sq. yd. (356 grams per square meter) (+/- 10%), 0.010-inch thick (0.25-mm thick), flame resistant (ASTM E84), Flame 20, Fuel 0, Smoke 30, rated 24 hours at -50°F (10°C), 200 hours at 250°F (121°C). Provide Tedlar Style TGH-1000 jacket as manufactured by Alpha Assoc., Inc. or Engineer-approved equal.
  - 1. Provide white, pre-formed, 30-mil (0.76 mm) PVC, fitting covers suitable for outdoor use, CEEL-CO 550 PVC Series insulated or Engineer-approved equal. Seal covers with adhesive as recommended by the manufacturer.

2.2 ADHESIVES

- A. Provide materials compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers 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.
    - d. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies 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," including 2004 Addenda.
- C. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Polyco VP Adhesive.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies 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," including 2004 Addenda.

### 2.3 MASTICS

- A. Provide materials compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use adhesive that has 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 one of the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
  4. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
  5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, CP-30 Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; Encacel.
  - b. Eagle Bridges - Marathon Industries; 570.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 60-95/60-96.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104°C).
4. Solids Content: ASTM D 1644, 33% by volume and 46% by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-10.
  - b. Eagle Bridges - Marathon Industries; 550.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 46-50.
  - d. Mon-Eco Industries, Inc.; 55-50.
  - e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6 mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

## 2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; 95-44.
  - d. 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°F (Minus 40 to plus 121°C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Use sealants that 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," including 2004 Addenda.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Co.; CP-76.
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°F (Minus 40 to plus 121°C).
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Use sealants that 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," including 2004 Addenda.

PART 3 - EXECUTION

3.1 INSTALLERS

- A. Install insulation with workers regularly engaged in this kind of work in strict accordance with the manufacturer's recommendations and recognized industry practices.

3.2 INSTALLATION

A. General:

1. Apply full-length units of insulation on clean, dry surfaces free of foreign matter. Apply only after tests and approvals required by the specifications have been completed.
2. Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Provide insulation and vapor seal at supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.
3. Finish raw edges with finishing cement.

B. Pipe Insulation:

1. Insulate pipe continuously through walls and floor openings except where walls and floors are required to be fire-stopped or required to have a fire-resistance rating. Where this occurs, fill the open space remaining between the sleeve and pipe with fire-stop.
2. Butt joints firmly together and smoothly, secure self-sealing jacket laps and joint strips with monel staples at 6-inch o.c. (150 mm o.c.) and cover with lap adhesive or factory (SSL) adhesive.

C. Insulation on Fittings and Valves:

1. Where the factory pre-molded one-piece PVC insulated fitting covers are to be used, apply the proper factory pre-cut insulation to the fitting using two layers for pipe temperatures above 250°F (121°C) or below 35°F (2°C), single layer insulation is suitable between 35°F (2°C) and 250°F (121°C). Tuck the ends of the insulation snugly into the throat of the fitting with the edges adjacent to the pipe covering, tufted and tucked in, fully insulating the pipe fitting. Overlap the covers to adjoining pipe insulation and jackets and seal all cold pipes at seam edges with vapor barrier adhesive. Seal the circumferential edges of covers with pressure sensitive tape. Overlap the tape on the jacket and the cover at least 1 inch (25 mm).

2. At locations where the PVC covers are prohibited, use as an alternate one of the following methods: one-coat insulation cement, pre-molded fiberglass fitting covers, or mitered segments of pipe insulation. Provide glass fabric embedded in fire-retardant mastic finish. Use vapor barrier mastic for cold piping for cold piping.
  3. Insulate valves with sections of fiberglass pipe insulation complete with all service jackets. Coat raw ends with vinyl acrylic mastic for hot piping or vapor barrier mastic for cold piping.
- D. Other Requirements:
1. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
  2. Repair sections of mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation; install new jacket lapping and seal over existing.
  3. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

**END OF SECTION 23 07 00**

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## SECTION 23 08 00 –COMMISSIONING OF HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes the commissioning process requirements for HVAC systems, assemblies, and equipment.
- B. Related Requirements:
  - 1. Division 01, Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
  - 2. For Pre-Functional Checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

#### 1.2 DEFINITIONS

- A. BAS: Building automation system.
- B. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."
- C. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
- D. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
- E. DDC: Direct digital controls.
- F. HVAC: Heating, ventilating, and air conditioning.
- G. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."
- H. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- I. TAB: Testing, Adjusting, and Balancing.

#### 1.3 SYSTEMS TO BE COMMISSIONED

- A. HVAC Systems:
  - 1. Cabinet Unit Heater
  - 2. Fin tube radiation
  - 3. Hydronic Pumps

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For HVAC testing technician.
- B. Submittals: Submittals associated with commissioned systems.



- C. Pre-Functional Checklists: Draft Pre-Functional Checklists will be created by CxA for Contractor review after receiving submittals accepted by the Engineer of Record.
- D. Functional Performance Tests: Material and installation checklists for equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."

#### 1.5 CLOSE-OUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC systems and components to include operation and maintenance manuals linked in Revit model.
- B. Record of Training of Owner's operation and maintenance personnel of commissioned systems.

#### 1.6 QUALITY ASSURANCE

- A. BAS Testing Technician Qualifications: Technicians to perform BAS pre-functional checklists and Functional Performance Tests shall have the following minimum qualifications:
  - 1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
  - 2. Minimum three years of experience installing, servicing, and operating systems manufactured by approved manufacturer.
  - 3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.
- B. HVAC Testing Technician Qualifications: Technicians to perform HVAC pre-functional checklists and Functional Performance Tests shall have the following minimum qualifications:
  - 1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
  - 2. Minimum three years of experience installing, servicing, and operating systems manufactured by approved manufacturer.
- C. Testing Equipment and Instrumentation Quality and Calibration:
  - 1. Capable of testing and measuring performance within the specified acceptance criteria.
  - 2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
  - 3. Be maintained in good repair and operating condition throughout duration of use on Project.
  - 4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- D. Proprietary Test Instrumentation and Tools:
  - 1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
    - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

- c. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 MEETINGS

- A. Commissioning Kick-Off Meeting: Within 90 days of selection of contractors or within 90 days of award of this contract, the CxA will provide a kick-off meeting to review roles and responsibilities of contractors during the construction process.
- B. Controls Coordination Meeting: After acceptance of controls submittal by the Engineer of Record, and prior to implementation, the CxA will organize a meeting to review the control sequences with the Owner, the Engineer of Record, the Controls Contractor, and the CxA.

### 3.2 SUBMITTALS

- A. The CxA will provide appropriate the general contractor with a list of HVAC submittals to be reviewed.
- B. The General Contractor or Architect will facilitate the distribution of submittals to the CxA.
- C. The CxA will review HVAC submittals within 10 business days

### 3.3 PRE-FUNCTIONAL CHECKLISTS

- A. Review and provide written comments on draft Pre-Functional Checklists. CxA will create required draft Pre-Functional Checklists and provide them to Contractor.
- B. Return draft pre-functional checklist review comments within 10 business days of receipt.
- C. When review comments have been resolved, the CxA will provide final Pre-Functional Checklists.
- D. Mechanical, Electrical, and Controls contractors will fill out their respective sections of the pre-functional checklists and note any outstanding deficiencies.
- E. Comply with Pre-Functional Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying plumbing systems and equipment.

### 3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Prior to functional testing, checks for the following conditions will be made:
  - 1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating per the Contract Documents and approved submittals. Contractors will document this information by filling out pre-functional checklists and providing start-up report.
  - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.

3. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved. A preliminary TAB report accepted by the CxA will serve as acceptable documentation.
  4. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- B. Functional Performance Test Conditions Perform tests using design conditions, whenever possible.
1. Simulated conditions may be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
  2. Functional Performance Test procedures may direct that set points be altered when simulating conditions is impractical.
  3. Functional Performance Test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
  4. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the building owner. After deficiencies are resolved, reschedule tests.
- C. Functional Performance Tests Common to HVAC Systems
1. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
  2. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.
  3. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
  4. Comply with pre-functional checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 23 Sections specifying HVAC systems and equipment.
  5. Contractor will provide technicians, instrumentation, tools, and equipment to perform and document the following:
    - a. Pre-functional checklists.
    - b. Functional Performance Tests.
- D. Execution of Functional Performance Test Procedures
1. The CxA will provide functional test procedures
  2. The controls contractor will execute functional test procedures. The CxA will witness and provide direction for execution of testing procedures.
  3. The CxA will document the test process, document issues, and notify contractors of outstanding issues. Contractors will correct outstanding issues.
  4. Acceptance Criteria: Operation of equipment according to OPR and BOD.

**END OF SECTION 23 08 00**

## SECTION 23 09 13 – INSTRUMENTATION AND 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 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Scope of work:
  - 1. Provide controls for all new equipment and integrate into building control system.
  - 2. All installations shall meet campus standards.
- B. Related Sections: Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specifications apply to this section.
  - 1. Division 23 equipment and system sections with specific control requirements.
  - 2. "Division 23 Section "Testing, Balancing, and Adjusting," for responsibilities and procedures of the TAB contractor.
  - 3. Division 26 sections for electrical equipment and wiring and conduit requirements and any electrical interface to the controls and instrumentation.
- D. Products Supplied, But Not Installed Under This Section:
  - 1. The automatic temperature control valves, separable wells for immersion sensors, shall be provided by the Controls Contractor for installation by the Mechanical Contractor under the Controls Contractor's supervision. Taps for flow and pressure instruments shall be located by the Controls Contractor for installation by the Mechanical Contractor.
  - 2. The Controls Contractor shall provide all automatic temperature control dampers which are not part of packaged equipment, for installation by the Mechanical Contractor under the Control Contractor's supervision.

#### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Utilize controllers and network protocol that matches the standard being used for the rest of the updated building controls as set forth by the UCD Controls Engineering Group.
  - 2. Coordination: This Contractor shall interface with controls furnished with equipment. Provide additional control devices, interlock relays, and signal conditioners and gateways/routers when necessary to accomplish specified sequences and interoperability.
  - 3. Electrical wiring in connection with the automatic temperature control system, where shown on the Division 26 drawings, shall be performed by the Electrical Contractor. All other wiring required for proper operation of the automatic temperature system shall be performed by this Contractor.
  - 4. Adjustments of manual balancing devices, as required to obtain design air and/or water flows, shall be by the Balancing Contractor. The Controls Contractor shall provide assistance to the Balancing Contractor with control adjustments as required to obtain design flows by:
    - a. Providing on-site instruction on the proper interfacing and operation of their equipment

- b. Providing the necessary software for use with the Balancing Contractor's personal computer for interfacing with their control equipment. Where proprietary software, equipment or gateways are required, this equipment shall be provided for the Balancing Contractor's use.
5. Commissioning of building systems shall be by the Commissioning Agent. This Contractor shall be responsible for startup, checkout, and debugging of all equipment installed and/or modified under this section. The Controls Contractor shall fully participate in the commissioning process and assist the Commissioning Agent with control demonstration and software adjustments, required for proper operation. This Contractor shall cooperate with the Commissioning Agent as to startup procedures, scheduling, performance verification, and system debugging. The Controls Contractor shall:
  - a. Provide on-site instruction on the proper interfacing and operation of their equipment and provide a printout of all software code and all user interface screens.
  - b. Provide the necessary software for use with the Commissioner's personal computer for interfacing with the control equipment. Where proprietary software, equipment or gateways are required, it shall be provided for the Commissioning Agent's use.
  - c. Provide any portable hand held setup/calibration devices required to initialize the control system for the Commissioning Agent's use.
  - d. Provide personnel to demonstrate the operation of the hardware and software during the commissioning process.
  - e. Commissioning of controls will be done by UCD Controls engineering group.
6. All installation work and programming shall conform to the UCD Construction Standards for HVAC control systems. Web address:

<http://www.ucdenver.edu/about/departments/FacilitiesManagement/Documents/GuidelinesStandards/2012%20edition/Part%204/Part%204%20Anschutz%20Bookmarked.pdf>

#### 1.4 SUBSTITUTION APPROVALS

- A. Where no specific manufacturer is listed, a first-class item of cataloged manufacture shall be furnished.
- B. Substitution Requests after Execution of Contract: If Contractor wishes to furnish or use a substitute item of material and/or equipment; he must submit a change order request to the Architect/Engineer. The request for change order shall itemize each of the proposed substitutions identified by applicable specification section, paragraph number and/or drawing number. A price change (increase or decrease) shall be listed for each item along with complete data showing performance over entire range, physical dimensions, electrical characteristics, material construction, operating weight and other applicable data. The change order request will be reviewed for equality, suitability and reasonableness of price differential. A single substitution change order listing the approved items will be issued with the net cost of the change order being the sum of the approved item costs. No subsequent substitution change orders will be considered. The Engineer's decision will be final.
- C. It shall be the responsibility of the Contractor to assure that the substitute material and/or equipment fits into the space provided and the Contractor shall pay for all extra costs incurred by other trades for any and all changes necessitated by these substitutions.

## 1.5 SUBMITTALS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.
- B. Schedule: Submittal data and control drawings for all equipment and systems shall be submitted to the Architect/Engineer for review prior to ordering or fabrication of the equipment. The following information shall be included in these submittals:
  - 1. 30 Days or Less After Notice to Proceed:
    - a. Control valve schedules.
    - b. The valve schedules shall also be submitted to the mechanical contractor for review by the piping and sheet metal contractors.
    - c. Product data including all products used in conjunction with the control system.
  - 2. 60 Days or Less After Notice to Proceed:
    - a. Control drawings
    - b. Software information
    - c. Test Plan and procedures
  - 3. 60 Days or More Prior to Scheduled Startup of the First Controlled System:
    - a. Software programming data
    - b. Test plan and procedures
  - 4. 10 Days or More Prior to Scheduled System Demonstration:
    - a. Operational trend studies (logs) as described in Part 3
    - b. Test plan with hardware and software testing results, calibration reports and technician certification
  - 5. Upon Completion of Training Classes:
    - a. Videotaped record of all training
    - b. One copy of all training materials
- C. Shop Drawings:
  - 1. General:
    - a. Drawings shall be prepared using computer aided drafting which can produce files compatible with AutoCAD 2005 or later.
    - b. Product data shall be in a 3-ring binder. All product information shall be indexed and tabbed. The product data sheets shall be marked with the tag number as indicated by the drawings. All options, ranges, and voltages that are to be provided shall be clearly indicated on each product data sheet.
  - 2. Valve Schedules:
    - a. Valve schedules may be included on the drawings or in the product data. The valve schedule shall include the following information:

- 1) Valve tag number
- 2) System and service
- 3) Quantity, manufacturer and model number
- 4) Type (2-way or 3-way)
- 5) Fail Position
- 6) Body Size
- 7) Flow (gpm)
- 8) Cv
- 9) Rangeability
- 10) Actual pressure drop
- 11) Close-off rating
- 12) Actuator model number
- 13) Actuator type and signal
- 14) Spring range

3. Drawings: The drawing package shall include:

- a. Cover sheet with a drawing index listing all included drawings.
- b. Control schematics and flow diagrams for each system monitored or controlled. These diagrams shall include:
  - 1) A ladder diagram showing all wiring and pneumatic tubing associated with the controller. The location of the electrical power panel with breaker number shall be shown for all power sources.
  - 2) Details showing the interconnection with motor starters, and other types of equipment. These details shall include wire numbers terminal designations and protocol and physical media (wire type). The mounting locations of all control equipment shall be included.
  - 3) A bill of materials shall be included with each control schematic. The bill of materials shall include the tag name used on the control drawing, description of the product, name of the manufacturer, complete model number, measurement range (if applicable) and quantity.
  - 4) A sequence of operation shall be included with each control schematic. The sequence shall reflect actual programming, including all time delays and software interlocks. Copies of the sequence that appear in this specification are not acceptable.
  - 5) Floor and roof plans showing the location of sensor, and mechanical equipment.

E. Quality Assurance/Control Submittals:

1. Test Plan and Procedures: The test plan shall include the following:
  - a. Certification documentation for each hardware point. Certify that the point was verified, tested and cycled to prove functionality. Include the calibration data, initial and final readings and the required offset.
  - b. Procedures for the seven-day test.
  - c. Certification documentation for software sequence of operation.
  - d. The test plan shall be coordinated with Division 23 Section "Testing, Adjusting, and Balancing" Contractor and Division 1 Section "General Commissioning Requirements".

F. Closeout Submittals - Project Record Documents:

1. Upon completion of the installation, provide a complete set of record (as-built) drawings. The content and format of the drawings shall be as described previously.

2. Prior to final completion of the installation, prepare complete Operation and Maintenance (O&M) manuals. Refer to Division 1, Section "Submittals" for requirements. Also provide one CD ROM containing all CAD-prepared drawing files compatible with AutoCAD 2005 or later.
3. The temperature control diagrams shall be laminated and secured to the panel.
4. Maintenance, installation, and engineering manual(s) that clearly explain how to debug hardware problems; how to repair or replace hardware; preventative maintenance guidelines and schedules; calibration procedures; and how to engineer and install new points, panels, and operator interfaces.
5. Documentation of all software: List separately all software parameters that may need updating by the Owner, such as, though not limited to, daily start/stop schedules; setpoints; alarm points; control loop cascade, and PID parameters, etc.
6. All programs, code, databases, graphic files, CAD drawings, and symbol libraries generated for operation of the system shall be included as part of the system documentation. This information shall be submitted both in hard copy bound format on CD-ROM.
7. Complete original issue documentation, installation, operation manuals, and supporting software for all third-party hardware and software furnished and installed as part of the system.
8. All software licenses, warranty certificates and documentation for all hardware and software including third party hardware and software shall be provided.
9. All testing, startup, calibration and checkout reports and checklists.
10. A list of recommended spare parts with part numbers and supplier.
11. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

#### 1.6 QUALITY ASSURANCE

##### A. Qualifications:

1. Approved Controls Manufacturers and Installing Contractors:  
Siemens Building Technologies                      Local branch office
2. Controls on the UCD Campus are sole-sourced to Siemens.

B. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing. This requirement is not intended to restrict the Contractor to the use of outdated equipment.

C. All products used in this installation shall be new and currently under manufacture. Spare parts shall be available for at least five years after completion of this contract.

D. All work, materials and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:

1. International Building Code (IBC)
  - a. Chapter 7, Smoke Dampers
  - b. Chapter 9, Duct Smoke Detectors
  - c. Chapter 9, Refrigerant Detector
2. International Mechanical Code (IMC)
  - a. Chapter 6, Wiring in Plenums
  - b. Chapter 11, Refrigerant Detector
  - c. Chapter 11, Refrigeration Machinery Room Ventilation



- d. Chapter 11, Refrigeration Machinery Room Remote Controls
3. American Society of Mechanical Engineers Controls and Safety Devices for Automatically Fired Boilers (ASME CSD-1a-2004) as adopted by the State of Colorado.
  - a. CE-110.a Manual Remote Shutdown
  - b. CW-210 Requirements for Flow Or Temperature Sensing Devices
4. International Fire Code (IFC)
5. National Electric Code (NEC)
6. Occupational Safety and Health Act (OSHA)
7. Applicable state and local codes

#### 1.7 WARRANTY

- A. Refer to the General Conditions of the Contract and Division 1 for general warranty requirements and duration.
- B. Special Warranty:
  1. The warranty period shall begin as authorized by the Owner's representative in writing. Completion shall not occur before the Contractor has performed the tests required in Article 3.
  2. The Contractor shall receive calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist. The response time to critical problems shall be four (4) hours maximum.
  3. The Contractor shall maintain a backup of all software installed in the system. A backup shall be made whenever the contractor makes a change to the software.
  4. The Contractor shall furnish and install all hardware, firmware, and software updates to operator workstations and controllers or web server software, project-specific software, graphic software, database software, and firmware that resolve identified software deficiencies at no charge during warranty period. Do not install updates or upgrades without Owner's written authorization. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items.

#### 1.8 DEMONSTRATION AND TRAINING

- A. This Contractor shall provide a minimum of four hours of system and control demonstration time at the job site for the Owner's personnel.

#### 1.9 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project-developed software and documentation shall become the property of the Owner. The Owner shall retain the right to duplicate and/or modify such for use at this facility. These documents shall not be copyrighted. These include but are not limited to:
  1. Project graphic images
  2. Record drawings
  3. Project database
  4. Job-specific application programming code
  5. All project specific documentation

#### 1.10 STARTUP AND TROUBLESHOOTING

- A. This contractor is responsible for the calibration, startup, and trouble shooting of the control system. This includes programming modifications to the control sequences to account for unanticipated operating issues and system performance.
  - 1. To reduce the number of changes, the contractor is encouraged to contact the Engineer prior to creating the job specific software to review the control sequence and other software requirements. The Contractor is encouraged to suggest alternative methods and sequences that meet the project goals.
  - 2. The intent of this specification is to provide the owner with a fully operational system. Sequence of operation changes may be required during startup and warranty period as noted above.
  - 3. The contractor shall make the required modifications at no additional cost.

### PART 2 – PRODUCTS

#### 2.1 CONTROL WIRING

- A. Cables shall be shielded when so recommended by manufacturer. Conductor size shall be in accordance with manufacturer's recommendations subject to specified minimum size. See Part 3 for allowable types.
- B. All low-voltage cables in plenums, not in raceway, shall be UL listed for air plenum service.
- C. All insulated wire to be copper conductors, UL labeled for 90°C minimum service.
- D. Raceway for wiring shall be per Division 26.

#### 2.2 TRANSIENT VOLTAGE PROTECTION

- A. TVSS surge protectors, for incoming 120V AC power to controllers: Leviton 51020WM, or Engineer-approved equal. Surge protectors furnished shall be UL 1449 listed. The maximum single-pulse transient current shall be 26kA, noise rejection at 50 ohms -40 to -50 for 5K to 100mhz, the cat B3 combination wave peak clamping voltage shall be L-N 300 V, L-G 350 V, the UL 1499 ratings shall be L-N330V, L-G 400V, Fault current rating (AIC rating assigned per UL) shall be 5,000A.
  - 1. Transient voltage protection for all twisted pair, telephone and coaxial data communication lines between controllers shall be per manufacturer recommendations. Provide all required repeaters to ensure signal integrity.
  - 2. Lightning arrestors on all communications and other lines that exit the building shall be per manufacturer recommendations.

#### 2.3 CONTROL VALVES

- A. Shall be 2-way or 3-way type for two-position or modulating service as scheduled, shown on drawings, or as specified in Sequence of Operation.
- B. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum closeout pressure ratings:
  - 1. Water Valves:
    - a. 2-way - 150% of total system (pump) head.

- b. 3-way - 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

C. Water Valves:

1. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
2. Rangeability of control valves shall be as follows:
  - a. Valves NPS 1/2 through NPS 1, 25:1 minimum
  - b. Valves NPS 1 through NPS 3, 50:1 minimum
  - c. Valves over NPS 4, 50:1 minimum
3. Sizing and Selection Criteria:
  - a. Flow velocities shall not exceed the manufacturer's recommendations.
  - b. Two-position service: Line size.
  - c. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 4 psi maximum, 2 psi minimum.
  - d. 3-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 3 psi maximum, 2 psi minimum.
  - e. 2-way modulating valves NPS 2 and smaller may be ball type valves with factory installed actuators (in lieu of globe type) for water service.
4. Materials:
  - a. Valves NPS 1/2 through NPS 2 shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc.
  - b. NPS 2-1/2 valves and larger shall be cast iron ANSI Class 125 with guided plug, stainless steel stems, and Teflon packing.
5. Ball Valves (water service only): Valve body shall be forged brass or bronze, two-piece construction with stainless steel ball and stem, reinforced Teflon seat and two O-ring packing, 600 psi (NPS 1/2 to NPS 1-1/4) 300 psi, (NPS 1-1/2 to NPS 4) pressure rating at 254°F. The valve shall have a flow characterizing disk in the inlet of the valve to provide an equal percentage response. Provide with factory assembled actuators. The valve actuator assembly shall have a minimum 200 psi close off. Belimo or Engineer-approved equal.
6. Water valves shall fail normally open or closed as scheduled on plans or as follows:
  - a. HW zone valves - normally open.
  - b. Heating coils in air handlers - normally open.
  - c. Other applications - as scheduled or as required by sequence of operation.

2.4 CONTROL DAMPERS

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
1. Control dampers shall be parallel or opposed blade type as below or as scheduled on drawings.
    - a. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade.
    - b. Other modulating dampers shall be opposed blade type.
    - c. Two-position shutoff dampers may be parallel or opposed blade.
  2. Damper frames shall be built to the structural equivalent of 13-gauge steel channel and shall be galvanized or extruded aluminum with reinforced corner bracing or welded corners.

3. Damper blades shall not exceed 8 inches (203mm) in width or 48 inches (1.2m) in length. Blades are to be suitable for medium velocity performance (2000 fpm) (10.2m/s). Blades shall be not less than 16 gauge.
4. Damper shaft bearings shall be oil impregnated bronze or stainless steel. Thrust bearings, and other special construction as required, shall be provided when dampers are to be used in blade-vertical position.
5. All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber, neoprene, or PVC-coated polyester fabric seals. Side seals shall be spring loaded stainless steel.
6. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 10.7 cfm per sq. ft. (33 L/s per sq. m) at a static-pressure differential of 4.0 inches water column (1000 Pa) when a torque of 5 inch pounds per sq. ft. (30.1 Newton meters per sq. m) is applied to the damper jackshaft.
7. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
8. Pressure drop shall not exceed 0.04 inch (10Pa) w.c. at a wide open face velocity of 1500 fpm (7.6m/s). The dampers shall have airfoil type blades.
9. Individual damper sections shall not be larger than 48" x 60" (1.2m x 1.5m). Provide a minimum of one damper actuator per section.
10. Ruskin CD60 airfoil or Engineer-approved equal.

## 2.5 SOLID-STATE SENSING DEVICES

- A. Temperature sensors shall be thermistor (10K or 20K), or platinum RTD type (100-ohm wire wound, or 1,000-ohm, thin film. Accuracy shall be  $\pm 0.5^{\circ}\text{F}$  with stability of  $0.25^{\circ}\text{F}$  over five years. Sensors used for BTU calculations shall be accurate to  $\pm 0.2^{\circ}\text{F}$  or 1% of span, whichever is less.
  1. Space (room) sensors shall be surface-mounted in a suitable protective enclosure. VAV terminal sensors shall have a network connection jack. Covers shall be blank, without any company logos. Omit thermometers and digital displays. Provide insulating mounting base on all sensors located on exterior walls. Provide metal guards with security screws for all sensors located in public areas such as lobbies, corridors, gyms, cafeterias, etc.

## 2.6 AUXILIARY DEVICES – ELECTRIC

- A. Current-operated switches shall be self-powered, solid state split core with manually adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system. The current switch shall have sufficient accuracy and hysteresis to detect drive belt failure. Where used in conjunction with variable frequency drives the current operated switch shall be recommended for such service by the manufacturer. Neilsen-Kuljian, Veris Industries or Engineer-approved equal.
- B. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage suitable for application. Idec series RH-L, ULAC or Engineer-approved equal.
- C. Control transformers shall be UL listed, Class 2 current-limiting type or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

## 2.7 SAFETY CONTROLS

- A. All safeties shall be hard wired. Safety interlocks using software are not acceptable.

## PART 3 – EXECUTION

### 3.1 DEMOLITION

- A. Demolition: This Contractor shall remove all unused controls including devices, conduit, wire, and pneumatic tubing. Disposition of hardware shall be coordinated with the Owner. Selected material shall be returned to the Owner. Coordinate work with other trades.

### 3.2 CONTROL EXECUTION - GENERAL

- A. This Contractor shall provide all required control interface relays, including control contactors for single-phase pumps and fans (1/2 hp or less) and any isolation relays required for interface to 3-phase magnetic starter control circuits. All power wiring to single-phase motors and 3-phase starters by Division 16; all control function (interlock) wiring by the Controls Contractor.
- B. This Contractor shall be responsible for providing control power to all his controllers and devices requiring control power including installation of any required breakers, unless such wiring is shown on the Division 16 drawings.
- C. This Contractor shall function as the Systems Integrator to establish interoperability with the controls system its LAN and controllers provided by other Sections including variable frequency drives (VFD), air handlers furnished with packaged controls, chillers and boilers, and other equipment designated to be connected on the LAN. This Contractor shall map all points indicated, connect wiring, provide any required converters, bridges or gateways and assure seamless bi-directional communication and interoperability and full functionality of the interface.
- D. Hand-Off-Auto switches at the MCC shall energize equipment in both the 'hand' and 'auto' mode (when auto is commanded on for auto mode). Safeties shall protect equipment in the hand and auto modes. Where fans are interlocked with damper end switches, the hand and auto positions shall open the dampers and the damper end switch shall energize the fan.

### 3.3 CONTROL WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with Division 16 the more restrictive requirements shall take precedence. Control wiring shall be concealed except in equipment rooms.
- B. All Power (line voltage) and Class 1 wiring shall be UL listed in approved raceway per NEC and Division 16 requirements.
- C. All Power limited circuits (Class 2 or Class 3) shall also be in metal raceway, except as follows:
  - 1. Concealed and accessible locations including ceiling return air plenums: Approved cables not in raceway may be used provided that:
    - a. Circuits meet NEC Class 2 or Class 3 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 or Class 3 current-limit.)
    - b. All cables shall be UL listed for application, i.e. Cables used in ceiling plenums shall be UL listed specifically for that purpose.
- D. Approved Cables not installed in raceways shall be subject to the following:
  - 1. Install wiring in a sleeve where wiring passes through walls and floors. Maintain the fire rating (if any) at all penetrations.

2. Cables shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, or ceiling suspension systems. All plenum cable and installation shall comply with the requirements of the NEC.
  3. Network data cables shall be identified with permanent labels installed every 12 feet.
  4. Exposed splices shall not be permitted. Cable shall be installed without splices between terminal points.
  5. Maintain a minimum of 6 inches from high temperature equipment (e.g., steam pipes, flues, etc.).
  6. Wire inside walls should be in conduit.
  7. Low voltage wire in ceilings should be run in the information system cable tray where available and should enter room along with other low voltage wiring through a 2" conduit from the cable tray to a point of penetration in the adjacent room and run on J Hooks or bridle rings in the ceiling space of a room.
- E. Size wire in accordance with manufacturers recommendations and the NEC.
- F. All wiring shall be installed as continuous lengths with no splices permitted between termination points.
- G. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support.
- H. This Contractor shall terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- I. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3 feet in length and shall be supported at each end. Flexible metal conduit less than 1/2-inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- J. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling or floors which separate adjacent rooms having substantially different maintained temperatures or when a raceway goes from indoors to outdoors.
- K. Wiring for analog inputs shall not be run in conduit containing 120V AC wiring or any wiring that carries switched signals or any noise-generating sources. Pneumatic tubing shall not be in the same conduit with wiring.
- L. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring. When plenum cable is not allowed, LAN or communication wire shall be installed in a dedicated raceway. Other wiring in communications raceway is not allowed.

### 3.5 TRANSIENT VOLTAGE PROTECTION

- A. This Contractor shall provide and install:
1. Transient voltage protection and backup power supply, on all incoming 120V AC power to all controllers (except VAV controllers).
  2. Transient voltage protection for all twisted pair, and coaxial data communication lines between controllers. Provide all required repeaters to ensure signal integrity.
  3. Transient voltage protection on all phone lines.
  4. Lightning arrestors on all communications and other wiring that exit the building. Locate the arrestor at the point of building entrance.
  5. Provide ground connection sized and installed in accordance with the manufacturers instructions.

### 3.6 CONTROL DEVICE LOCATIONS

- A. Room thermostats and sensors shall be mounted 44 inches from the finished floor to the center of the device for ADA Compliance. Seal the wall opening and wire penetration of all wall-mounted temperature sensors to prevent airflow from the wall cavity, from affecting the sensor reading.
- B. Provide thermal conducting compound for all sensors in thermowells.

### 3.7 IDENTIFICATION

- A. All control equipment shall be clearly identified by control shop drawing designation as follows:
  - 1. Control valves - brass tags.
  - 2. Other remote control devices and sensors: metal tags; plastic laminate labels; or, on non-porous surfaces only, permanent label tape as produced by the Brother "Easy Touch" label maker. Do not attach tag or label to removable covers, etc. Rivet or stick to device or adjacent surface.
  - 3. All wiring, including wiring within factory-fabricated panels, shall be labeled within 2 inches of termination with DDC point number/controller number or other descriptive information.
  - 4. All metal and plastic engraved labels shall be secured with chains, nylon tie-wraps, or rivets. Screws with exposed threads are not acceptable. Permanent adhesive is acceptable only when mechanical fasteners would damage the labeled equipment.
  - 5. All switches, relays, and panel components shall be labeled. Relays shall be labeled such that removal of the relay does not move the label.
  - 6. Raceway identification: For ease of identification, junction and pull box covers shall be color coded. Coordinate the color of the junction box covers with Division 16 and the Owner.

### 3.8 TESTING

- A. Prior to substantial completion, the control system shall undergo a series of tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed their own performance tests.
- B. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process. Control system testing shall be coordinated with the Commissioning Contractor and scheduled with the Owner's representative.
- C. The Contractor shall provide at least two men equipped with two-way communication, and shall test actual field operation of each control and sensing point for all modes of operation including day, night, summer, winter, occupied, unoccupied, fire/smoke alarm, and power failure modes. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor. The Commissioning agent and the Owner's Representative (at their discretion) may observe and review these tests.
- D. A point-to-point verification shall be made for each input and each output to the system. The check shall include the operator workstation such that the correct point assignment at the workstation is also verified. The calibration of all input and output points shall be tested, documented and calibrated as needed.
- E. The operation of each hardwired safety and interlock shall be tested. This testing shall verify the correct operation of the safety or interlock in the hand and automatic modes of operation.
- F. Each alarm shall be tested. The receipt of the correct alarm message shall be verified for each alarm and device receiving the alarms. Dial out and email alarms shall be verified.
- G. Power failure restart and software backup during power failure shall be tested.
- H. There shall be a seven day demonstration test. During a seven-consecutive-day period, the system shall function in automatic mode without any overrides or operator intervention. Failure of any components, control sequences or the inability to deliver uninterrupted services shall be deemed a failure of the test. This contractor shall submit system logs demonstrating a successful test.

- I. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this section have been performed to the satisfaction of both the Engineer and Owner and all required documentation has been submitted and successfully reviewed. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

**END OF SECTION 23 09 13**



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## SECTION 23 09 93 - HVAC SEQUENCE OF OPERATION

### PART 1 - GENERAL

#### 1.1 DEFINITIONS

- A. DDC: Direct digital controls
- B. VAV: Variable air volume

### PART 2 – PRODUCTS (Not Applicable)

### PART 3 – EXECUTION

#### 3.1 CONTROL EXECUTION - GENERAL

- A. All trend logs and test data required by 23 09 13 Part 3 shall be provided.
- B. All set points, operating points, sequencing ratios, PID tuning parameters, and all other numeric and digital constants shall be adjustable by the user (only with a high-level password) from the graphic. To change these values, the user shall not be required to modify program code, recompile, or download. All points and virtual points shall be capable of being overridden or having a specified value “fixed” from the central workstation to facilitate software testing. To override such a point, the user shall not be required to modify program code, recompile, or download.
- C. Provide independently adjustable, minimum 'on' and 'off' timers for each start/stop point. Initially set times so as not to exceed six starts per hour. On two-speed motors, provide a 20-second adjustable time delay when transferring from high-speed to low-speed to allow the load to decelerate.
- D. System logs, trend logs, and event-initiated logs shall be set up to provide historical and real-time monitoring of system operation. Logs shall include all points associated with the equipment group. Logs shall be grouped by equipment.
- E. Every digital and analog input shall have an alarm assigned to it. Alarm points shall be locked out when equipment is not in use. Provide time delays to prevent false alarms during equipment startup. When a set point is reset, the alarm limits shall be reset. These alarm limits shall be a constant offset from the set point. The alarm set points shall be initially set by this contractor in conjunction with the Owner.
- F. E-mail Alarms: Alarms shall be programmed to initiate an e-mail to selected e-mail recipients. Alarms that cause email notification shall be user selectable. Every 24 hours at a user-selected time, the system shall dial out a welfare check message.

#### 3.2 GLOBAL COMMANDS FOR TEST AND BALANCE

- A. There shall be a user command, accessible only with a high-level password, that will allow the user to command all control valves on each individual system to either the 100% open position or the closed position. This command shall be activated by commanding a single point. The command shall be grouped by system (boiler, chiller) so that each system can be operated separately.

### 3.3 CABINET UNIT HEATER

- A. The space thermostat shall modulate the control valve and cycle the unit fan to maintain space temperature at set point of 60°F (adjustable). When heating water is not available, as sensed by the aquastat, the fan shall be de-energized. The BAS shall monitor discharge air temperature and fan status.

### 3.4 BASE-BOARD HEATING

- A. Fin tube radiation shall be sequenced with the associated VAV box. Heating with fin tube and cooling with the VAV box shall not occur simultaneously. Where the baseboard is not associated with a VAV box, the space temperature sensor shall cycle the baseboard to maintain the space temperature set point.

### 3.5 HYDRONIC PUMPS

- A. New pumps shall operate on the existing sequence of operations. Connect to existing controls.

END OF SECTION 23 09 93

## SECTION 23 21 13 – 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 Specifications, apply to this Section.

#### 1.2 SUBMITTALS

- A. Product Data: Submit product data on piping materials, methods, and specialties.

#### 1.3 QUALITY ASSURANCE

- A. Certifications: All safety valves and pressure vessels shall bear the appropriate ASME label and stamp.

### PART 2 - PRODUCTS

#### 2.1 PIPING

##### A. Specification A:

1. Pipe: ASTM B88, Type L drawn temper seamless copper tube.
2. Fittings: ASME B16.22 wrought copper, ASME B16.18 cast copper alloy, or wrought-copper Viega ProPress fittings with EPDM-rubber O-ring seal in each end.
3. Flanges: ASME B16.24, Class 150 cast bronze flanges with solder joint ends
4. Unions: ASME B16.18, cast-copper alloy, hexagonal stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder joint and/or threaded ends
5. Solder Filler: ASTM B 32, Alloy Sn95, Sn94 or E; lead- free
6. Brazing Filler Metal: AWS A5.8 BcuP, copper phosphorus or BAg, silver classification

##### B. Specification B:

1. Pipe: ASTM B88, Type M drawn temper seamless copper tube
2. Fittings: ASME B16.22 wrought copper, ASME B16.18 cast copper alloy, or wrought-copper Viega ProPress fittings with EPDM-rubber O-ring seal in each end.
3. Flanges: ASME B16.24, Class 150 cast bronze flanges with solder joint ends
4. Unions: ASME B16.18, cast-copper alloy, hexagonal stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder joint and/or threaded ends
5. Solder Filler: ASTM B 32, Alloy Sn95, Sn94 or E; lead-free
6. Brazing Filler Metal: AWS A5.8 BcuP, copper phosphorus or BAg, silver classification

##### C. Specification C:

1. Pipe: ASTM A53, ERW, Grade B carbon steel pipe
  - a. NPS 1/2 (DN 13) and Smaller: Schedule 80
  - b. NPS 3/4 (DN 18) to NPS 10 (DN 250): Schedule 40
  - c. NPS 12 (DN 300) and Larger: Standard weight

2. Fittings:
    - a. NPS 2 (DN 50) and Smaller: ASME B16.4, Class 125 cast-iron threaded fittings, ASME B16.3, Class 150 malleable-iron threaded fittings
    - b. NPS 2-1/2 (DN 65) and Larger: ASTM A234, Grade WPB, butt weld standard weight wrought carbon steel
  3. Unions: ASME B16.39, Class 150 malleable-iron union
  4. Flanges: ASME B16.5, Class 150, ASTM 181 Grade. II, carbon steel, raised face
- D. Specification D:
1. Pipe: ASTM A53, seamless, Grade B carbon steel pipe
    - a. NPS 1/2 (DN 13) and Smaller: Schedule 80
    - b. NPS 3/4 (DN 18) to NPS 10 (DN250): Schedule 40
    - c. NPS 12 (DN 300) and Larger: Standard weight
  2. Fittings:
    - a. NPS 2 (DN 50) and Smaller: ASME B16.4, Class 250 cast-iron threaded fittings, ASME B16.3, Class 300 malleable-iron threaded fittings
    - b. NPS 2-1/2 (DN 65) and Larger: ASTM A234, Grade WPB, butt weld standard weight wrought carbon steel
  3. Unions: ASME B16.39, Class 300 malleable-iron union
  4. Flanges: ASME B16.5, Class 300, ASTM 181 Grade. II, carbon steel, raised face
- E. Specification E:
1. Pipe: ASTM A53, seamless, Grade B carbon steel pipe
    - a. NPS 10 (DN250) and Smaller: Schedule 80
    - b. NPS 12 (DN 300) and Larger: Extra strong
  2. Fittings:
    - a. NPS 2 (DN 50) and Smaller: ASME B16.4, Class 250 cast-iron threaded fittings, ASME B16.3, Class 300 malleable-iron threaded fittings
    - b. NPS 2-1/2 (DN 65) and Larger: ASTM A234, Grade WPB, butt-weld standard weight wrought carbon steel
  3. Unions: ASME B16.39, Class 300 malleable-iron union
  4. Flanges: ASME B16.5, Class 300, ASTM 181 Gr. II, carbon steel, raised face
- F. Specification F:
1. Pipe: ASTM A53, ERW, Grade B carbon steel pipe with grooves designed to accept grooved end couplings
    - a. NPS 2-1/2 (DN 65) to NPS 10 (DN250): Schedule 40
    - b. NPS 12 (DN 300) and Larger: Standard weight

2. Mechanical Grooved Pipe Fittings:

- a. Grooved Mechanical-Joint Fittings: ASTM A536, Grade 65045012 ductile iron, ASTM A47 malleable iron or ASTM A53 Type E or S Grade B fabricated steel; or ASTM A-106 Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. Manufacturers are Central, Grinnell, Gruvlok, Star, or Victaulic
- b. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure responsive design; with nuts, bolts, locking pin, locking toggle or lugs to secure grooved pipe and fittings. Rigid couplings shall be used unless otherwise noted on drawings. Manufacturers are Central, Grinnell, Gruvlok, Star, or Victaulic

G. Specification G:

1. Pipe: PVC Pipe: ASTM D 1785, Schedule 40.
2. Fittings: PVC Plastic Pipe Fittings, ASTM D 2466 for Schedule 40.
  - a. PVC solvent cement used within buildings shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - c. Solvent cement and adhesive primer used within buildings 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."
3. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION SURVEYS

A. Surveys – Measurements, Lines, and Levels:

1. Check dimensions at the building site and establish lines and levels for the work specified in this section.
2. Establish all inverts, slopes, and elevations by instrument, working from an established datum point. Provide elevation markers and lines for the Owner's use to determine that slopes and elevations are in accordance with drawings and specifications.

B. Pipe Cleaning:

1. Clean interior of all piping before installation. Remove any fugitive dust, dirt, and/or threading debris.
2. Flush sediment out of all completed piping systems. Refer to Division 23 Section "Common Work Results for Mechanical Systems," for cleaning and flushing requirements.

3.2 PIPING APPLICATIONS

A. Heating Water:

1. NPS 2 (DN 50) and Smaller: Pipe specification ACD

2. NPS 2-1/2 (DN 65) and Larger: Pipe specification CD
- B. Low-pressure Steam: Pipe specification CD
- C. Medium- and High-pressure Steam: Pipe specification D
- D. Steam Condensate and Steam Blowdown: Pipe specification E
- E. Coil Condensate, Blowdown (*except steam*), Drain, and Vent:
  1. NPS 2 (DN 50) and Smaller: Pipe specification AB
  2. NPS 2-1/2 (DN 65) and Larger: Pipe specification C
- F. Mechanical Grooved Piping System: Pipe specification F is acceptable for chilled water, heating water and tower water pipe within mechanical equipment rooms only.

### 3.3 INSTALLATION

#### A. Piping Installation - General:

1. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, other design considerations. So far as practical, install piping as indicated. Ductwork shall take precedence over piping when coordinating work with other trades.
2. Provide a complete piping installation, including connections to equipment and installation of automatic control valves furnished by the Temperature Control Contractor. Install control valves with a minimum length equivalent to four pipe diameters of straight pipe entering valve and with the stem upright.
3. Support piping at connections to pumps so there is no strain on pump flanges.
4. Pitch piping to obtain required air relief and drainage.
5. Make an allowance for expansion in the installation of piping so the variation in temperature will not cause undue stress at any point. Securely anchor pipes where necessary to properly distribute expansion stresses. Support branch mains and risers in a way that will permit expansion and contraction of risers and to relieve runouts of all weight.
6. Provide unions or flanges at each control valve and at each piece of equipment.
7. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below Grade or floors, unless indicated to be exposed to view.
8. Refer to Division 23 Section 23 05 29 "Hangers and Supports for Mechanical Systems," for additional installation requirements. Refer to Division 23 Section 23 05 48 "Wind, Seismic, and Vibration Controls for HVAC for Mechanical Systems" for seismic restraints.

- B. Steam Supply and Condensate Return Pipe Installation: Install steam supply and return lines with straight side of eccentric fittings at bottom of pipe. All steam lines shall pitch 1 inch per 40 feet in the direction of flow. Return piping shall pitch down 1:360 in the direction of flow. Runouts from steam mains to risers shall be pitched back to the main with a fall of not less than 4%.

### 3.4 FIELD QUALITY CONTROL

#### A. Pipe Testing:

1. All piping systems shall be tested and proven tight prior to insulation or concealment. The tests shall be witnessed by the Owner's Representative or his designee.

2. 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
3. Ensure that the test pressure, which might damage equipment, does not reach such units by valving them off or otherwise isolating them during the test.
4. Open and close all system valves at least once while system is pressurized to test valve packing. Tighten as required.
5. All hydrostatic tests shall be held for a minimum of four hours without loss of system pressure.
6. Test pressures shall be as follows:
  - a. Hot Water/Chilled Water: 100 psig (690 kPa) hydrostatic or 1.5 times operating pressure, whichever is greater
  - b. Low-pressure Steam and Condensate Piping: 100 psig (690 kPa) hydrostatic or 1.5 times operating pressure, whichever is greater
  - c. Condensate Drain and Blow-Down Drain Piping: plug outlet, fill pipe with water to inlet, and visually inspect for leaks

**END OF SECTION 23 21 13**



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## SECTION 23 21 16 – HYDRONIC PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: This section covers general requirements for valves and specialties that are used with piping systems as specified elsewhere in Division 15.

#### 1.2 RELATED DOCUMENTS

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

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Strainers
  - 2. P&T test plugs and accessories
  - 3. Thermometers
  - 4. Gauges
  - 5. Flow measuring devices
  - 6. Hydronic Specialties

#### 1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Refer to Division 23 Section "Common Work Results for HVAC" for general code, standard and regulatory requirements.
  - 2. Chemical and physical properties of materials, performance characteristics, and methods of construction shall be in accordance with applicable sections of the following references and standards of current editions in effect 90 days prior to receipt of bids:
    - a. American Welding Society (AWS)
    - b. Commercial Standards, National Bureau of Standards (CS)
    - c. Compressed Gas Association (CGA)
    - d. Copper Development Association (CDA)
    - e. Federal Specifications (FS)
    - f. Manufacturers Standardization Society (MSS)

### PART 2 - PRODUCTS

#### 2.1 STRAINERS

- A. Water and Steam:
  - 1. Bronze Y-type strainers with stainless steel screens. 2 inches or smaller shall be screwed or sweat (water only), 400 psi WOG/300 psi SWP with 20 mesh screen, equal to Armstrong, A W Cash, Boylston, Hoffman, ITT, Keckley, Mueller or Plenty.
  - 2. 2-1/2 inches and larger shall be cast iron flanged, Class 125, 125 psi steam or 200 psi non-shock WOG or Class 250, 250 psi steam or 500 psi non-shock WOG with 3/64-inch perforated screen, equal to Conbraco F-1, Sarco CI/F-125/250, or Streamflow YF-125/F 250.

## 2.2 PRESSURE TEMPERATURE TEST PLUGS AND ACCESSORIES

- A. Approved manufacturers are as follows:
  - 1. Test plugs - Peterson Equipment No. 710 or 710-XL, Fairfax, or Trerice.
  - 2. Pressure gauge - Duro Instrument Corp. No. 105 with adapter.
  - 3. Pocket Thermometers - Peterson Series 600, or Tel-Tru Manufacturing Co. No. 39R.
- B. Pressure temperature test plugs (P & Ts) shall have brass body with Nordel valve core, gasketed cap with retaining strap, 1/4-inch or 1/2-inch male pipe thread and insulation extension where required. Rated 250 psi at 275°F.

## 2.3 PERMANENT THERMOMETERS

- A. Approved manufacturers are Cooper, Davis, Duro Instrument Corp., Marshalltown, Weiss Instruments, H. O., Taylor, Trerice Co., Moeller, Weksler, Tel-Tru.
- B. Thermometers shall have die-cast case with baked enamel finish; green reading non-toxic fluid-filled tube with suitable 9-inch scale; adjustable multi-angle housing, brass separable socket similar to Tel-Tru Ecogreen.
- C. Shall be Vari-angle digital type, 40°F to 300°F, with LCD readout (no batteries). Weiss Instruments Model DVU 35.
- D. Stem length shall be sufficient for 40% - 60% insertion. Accuracy 1% full scale or better. All thermometers inserted in piping systems shall be provided with a thermowell for isolation.

## 2.4 PRESSURE GAUGES

- A. Approved manufacturers are Duro Instrument Corp., Dwyer Instruments, Inc., H.O. Trerice Co., Ametek U.S. Gauge Division, Marshalltown, Mueller Brass, U.S. Gauge, Weksler, Weiss Instruments.
- B. Single input pressure gauges shall have stainless steel case; 4-1/2-inch dial with suitable range; phosphorous bronze Bourdon tube; corrosion-resistant movement; adjustable steel pointer; 1% of full scale accuracy; 1/4-inch NPT brass connection, Duro Series 800 or approved equal.
- C. Differential pressure gauges shall have forged brass case, 4-inch dial, 500 psi WOG, accuracy of  $\pm 3\%$  of full scale. Dwyer Series 4,000 with ASF adjustable signal flag. Model 4635B for flat plate, condenser, and evaporator pressure drops.

## 2.5 FLOW-MEASURING DEVICES

- A. Line sizes and design flow rates are shown on the drawings.
- B. Flow-measuring devices shall be a combination measuring device and balancing valve assembly or a separate Venturi with a remote balancing valve. Contractor options are:
  - 1. One-piece combination orifice (1 inch and smaller) or Venturi (2 inches and smaller) and ball type balancing/shutoff valve as follows:
    - a. Bronze or forged brass construction with sweat or threaded ends, rated at 250 psi SWP at 250°F.
    - b. Full-port, ball valve with chrome-plated ball and blowout-proof stem with Teflon seals and packing, 100% shutoff at rated pressure.
    - c. Quick-connect type color-coded fittings for flow measurement connection.

- d. Tamper-resistant adjustable "memory" device for valve setting stop.
  - e. Metal tag with orifice/Venturi size, station designation, and gpm/meter reading.
  - f. Readout ports and valve handles shall have 2 inches or greater extensions when pipes are to be insulated.
  - g. Selected for meter readout of 7 inches to 50 inches w.g. to maximum at rated flow.
  - h. Acceptable manufacturers are Flow Design "AccuSetter," Gerand Series 200, and HCI "Terminator B."
- C. Alternately, flow-measuring devices 2-1/2 inches and larger shall consist of a venturi unit as follows:
1. Sizes 2-1/2 inch diameter and larger may be cast steel with weld ends, machined steel for butt welding, or grooved joint type. Sizes 10 inches diameter and larger may be fabricated steel with weld ends. Device to be rated for 150 psi SWP at 250°F, unless otherwise noted.
  2. Venturi unit shall include manual shut-off valves and quick-disconnect fittings at meter taps and shall be furnished with tags marked with Venturi size, station designation, gpm, and meter reading for gpm.
  3. Bore sizes shall be selected so the meter readout at specified flow rate is between 7 inches and 50 inches w.g. to unless otherwise noted.
  4. Acceptable manufacturers are Gerand, Flow Design and HCI.

## 2.6 HYDRONIC SPECIALTIES

### A. Air Vents:

1. Manual air vents: Use ball valve with hose end and cap.
2. Automatic Air Vent: Spirotop air vent only.

### B. Diaphragm/Bladder Type Expansion Tanks: Provide minimum acceptance volume and tank volume as indicated on drawings.

1. 37 Gallons and Larger: ASME 125 psi (860 kPa) construction, full acceptance type, Amtrol L bladder tank series, B&G B series, Taco CA series, equal by Armstrong or Expanflex.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed in accordance with the recommendations of the manufacturer. Maintain maximum headroom and space conditions at all points.
2. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Use fire stop caulking materials at all fire-rated wall penetrations.

#### B. Strainers:

1. Install strainers at suction side of all HVAC pumps, ahead of all solenoid and automatic control valves, and where shown on plans.
2. Install strainers ahead of all steam traps and steam control valves and where shown on plans.
3. Install a ball valve with hose end and cap for blow-off on strainers.

4. All strainer screens shall be removed, cleaned, and reinstalled after system pressure tests, cleanup, and startup is complete and before final acceptance. The strainers shall be marked for verification purposes after final cleaning and reinstallation.

C. Air Vents:

1. Install manual air vents at high points of all piping consisting of a line size nipple – 6 inches long for an air collection chamber, pipe cap on top of nipple with 1/4-inch tap, 1/4-inch copper tubing with gauge cock. Locate gauge cock at accessible location and anchor to adjacent pipe or wall. Provide access panels as required for access.
2. Install manual air vents at all heat transfer devices, coils, etc.

D. Hydronic Specialties:

1. Install hydronic specialties of types and sizes as shown and/or scheduled on the plans.
2. Install pot-type 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 bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Provide drain with ball valve, piped to daylight at nearest floor or equipment drain.

E. Other Devices:

1. Install a pressure-temperature tap on each side of each boiler, chiller, pump, and heat transfer device such as coils, heat exchangers, radiation, and radiant panel loops.
2. Install thermometers and gauges where shown on drawings. Locate them so they are easily visible from the floor level without use of ladders, etc. Provide a P&T tap at each thermometer, sensor, and gauge location.
3. Provide heat transfer grease in each thermometer well and a pressure snubber and shutoff valve for each pressure gauge.
4. Install one flow-measuring device in the return water from (to) each heat transfer or generation device (such as boilers, chillers, pumps, coils, heat exchangers, radiation circuits, etc.). The balancing valve may also serve as an isolation valve provided it has adjustable memory stops.

- F. Accessibility: Locate all equipment that must be serviced, operated, or maintained in fully accessible positions. Equipment shall include, but not be limited to, valves, traps, cleanouts, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

**END OF SECTION 23 21 16**

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## SECTION 23 21 23

### HYDRONIC PUMPS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes: This section covers general requirements for HVAC pumps and accessories of the following types:
  1. Vertical in-line pumps

##### 1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Pump types and capacities are as shown and/or scheduled on the drawings.
- B. Design Criteria: The drawings indicate sizes, profiles, connections, and dimensional requirements of HVAC pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided deviations in dimensions, profiles, electrical requirements, and efficiencies do not change the design concept or intended performance as judged by the Engineer. The Contractor shall be responsible for any subsequent costs associated with pumps by other manufacturers. A stamped submittal will not relieve the Contractor of this responsibility.
- C. Pumps as described in this section shall be furnished for the following systems:
  1. Heating water

##### 1.04 SUBMITTALS

- A. Product Data:
  1. Include Manufacturer's Standard Pump and Motor balance (vibration) criteria.
  2. Product data including certified performance curves, selection operating point, furnished accessories. Pump curves shall include ISO-hp curves to determine overload potential.
  3. Include pump motor data.
- B. Shop Drawings: Provide shop drawings for all pumps furnished under this section. Shop drawings shall include certified dimension drawings with shipping, installed and operating weights, weight distribution, and installation recommendations.
- C. Closeout Submittals: Provide operating and maintenance (O&M) data for all HVAC pumps.

##### 1.05 QUALITY ASSURANCE

- A. Certifications:
  1. All pump motors shall be NEMA rated and UL listed.
  2. Certified performance data shall be furnished for all custom and non-cataloged pumps.
  3. Fabricate and label pumps to comply with UL 778, "Motor Operated Water Pumps" for construction requirements.

## PART 2 – PRODUCTS

### 2.01 GENERAL

- A. Provide factory-tested pumps that are thoroughly cleaned and painted with one coat of machinery enamel prior to shipment.
- B. Provide all pumps of same type by the same manufacturer.
- C. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.
- D. Motors shall conform to NEMA Standard MG-1, general purpose, continuous duty, Design B speed with type of enclosure and electrical characteristics as indicated, and grease-lubricated ball bearings.
  - 1. Select motors that are non-overloading within the full range of the pump performance curve.
  - 2. Select motors for continuous duty at altitude; provide Class F insulation where required to meet ambient/altitude operating requirements at 1.0 service factor.
  - 3. Motor Efficiency - All 3-phase motors shall be NEMA Premium™ Design
  - 4. Provide a shaft grounding kit for all motors connected to a variable frequency drive.
- E. Nameplate efficiency shall be equal to or greater than "nominal efficiency" values listed in the NEMA Premium™ "Product Scope and Nominal Efficiency Levels".
- F. All pump motors 1 hp or larger shall be of the premium efficiency type per Division 23 Section "Common Work Requirements for HVAC Systems" except as noted.
- G. Vibration shall be such that the value of self-excited vibration velocity is less than 0.10 inch/second when measured with a vibration meter on the frame or bearings of the pump assembly in any of the three axes. The pump and motor assemblies shall be both statically and dynamically balanced so as not to exceed the vibration limits specified.
- H. Nameplates showing pump manufacturer's name, model and/or serial number, impeller size, and motor data shall be clearly visible. If impeller has been trimmed from standard size, this information shall appear on nameplate also.

### 2.02 MANUFACTURERS

- A. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - 1. Base-Mounted, Separately-Coupled, End-Suction Pumps:
    - a. "Series 4030," Armstrong Pumps, Inc.
    - b. "340 Series," Aurora Pumps
    - c. "Series 1510," Bell & Gossett, Xylem

### 2.03 BASE-MOUNTED, SEPARATELY-COUPLED, END-SUCTION PUMPS

- A. General: Pumps shall be base-mounted, centrifugal, separately-coupled, end-suction, single-stage, bronze-fitted, radially split-case design, and rated for 175 psig working pressure and 225°F continuous water temperature.



- B. Casings: Cast iron with flanged piping connections and threaded gauge tappings at inlet and outlet flange connections.
- C. Impeller: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B584, keyed to shaft and secured by a locking capscrew. Replaceable bronze wear rings.
- D. Pump Shaft and Sleeve Bearings: Steel shaft with bronze sleeve.
- E. Seals: Mechanical seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
- F. Pump Couplings: Flexible, capable of absorbing torsional vibration, complete with metal coupling guard. Flexible couplings shall not be used to compensate for misalignment of pump.
- G. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B36. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.
- H. Motor: Secured to mounting frame with adjustable alignment on mounting frame, ODP with regreasable ball bearings.

### PART 3 – EXECUTION

#### 3.01 INSTALLATION

- A. General:
  - 1. Comply with the manufacturer's written installation and alignment instructions.
  - 2. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
  - 3. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- B. Connections:
  - 1. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
  - 2. Install a non-slam check valve and balancing valve on the discharge side of all pumps. Valves shall be same size as system piping.
  - 3. Install a shutoff valve and strainer on the suction side of all pumps. Valves shall be same size as system piping.
  - 4. Install pressure/temperature test plugs on the suction and discharge of each pump housing using the integral pressure gauge tappings provided.
    - a. Install pressure gauge with shutoffs where shown.
    - b. Install other pressure/temperature test plugs in piping around pumps as shown. Pressure/temperature test plugs and gauges are specified in Division 23 Section "HVAC Piping Specialties."

#### 3.02 FIELD QUALITY CONTROL

- A. Check suction line connections for tightness to avoid drawing air into the pump.

3.03 STARTING AND ADJUSTING

- A. Final Checks Before Startup: Perform the following preventative maintenance operations and checks before startup:
  - 1. Lubricate oil- and/or grease-lubricated bearings.
  - 2. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
  - 3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
  - 4. Check to see that the check valve is operational, the suction and discharge valves are open, the discharge balancing valve is open, and that there is some downstream flow called for.
- B. If the pump is noisy, it must be repaired or replaced to meet the Owner's satisfaction.

3.04 TESTING, ADJUSTING, AND BALANCING

- A. Refer to the applicable section of Division 23 for detailed requirements of testing, adjusting, and balancing hydronic systems.

**END OF SECTION**

## SECTION 23 25 00

### WATER TREATMENT

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes: This section covers general requirements for equipment, chemicals, and services related to the cleaning of pipe lines and equipment, and water treatment for mechanical systems.
  - 1. Closed Systems with Propylene Glycol:
    - a. Hot Water Heating: 150 gallons @ 30% glycol by volume

##### 1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including rated capacities of selected equipment clearly indicating water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.
- B. Chemicals: Submit data on all chemicals to be used, including material data safety sheets.
- C. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- D. Closeout Submittals: Submit Operating and Maintenance (O&M) data and parts lists for each item of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include chemical data and material data safety sheets.

##### 1.04 QUALITY ASSURANCE

- A. Qualifications:
  - 1. A single water treatment company shall be responsible for all products and services. This company shall be a recognized specialist in the field of industrial water treatment with full-time personnel available to the contractor.
  - 2. The water treatment equipment, chemical, and service supplier shall have been active in the field of commercial/industrial water treatment for not less than five years and shall have full-time service personnel located within the trading area of the job site. Engineer-approved vendors are:
    - a. Aqua-Chem, Inc.
    - b. Calcium Control, Inc.
    - c. Dychem International
    - d. Garratt-Callahan Co.
    - e. International Chemtex Corp.
    - f. Nalco Chemical
    - g. H<sub>2</sub>O Industries
    - h. Rocky Mountain Aquatech

## 1.05 MAINTENANCE

- A. Chemical Treatment Service:
1. Chemical Treatment for Systems: The water treatment vendor shall provide sufficient chemicals to treat all specified systems for the entire warranty period based on the type of duty that the systems are operating under.
  2. Provide service calls at least once a month, or more often when necessary, from one month prior to turnover until the end of the warranty period. Service calls shall include complete chemical treatment services for all systems being treated. Some of the specific services to be performed are as follows:
    - a. Check all coupons at least every other month for excessive corrosion. Replace coupons and alter treatment when indicated.
    - b. Check for proper water treatment results in all systems being treated.
    - c. Check for proper chemical usage (keep chemical usage to a minimum).
    - d. Change biocide monthly on towers when not automatic.
    - e. Perform water analysis on the different waters being serviced. Log the test results, pump settings, chemical usage, etc., in a 3-ring binder that is to be kept at job site.
    - f. Add chemical to closed systems when required.
  3. Written chemical test reports and recommendations shall be made at each visit with one copy to the Owner's designated representative and one copy to the Engineer.
- B. Extended Maintenance Service: Agreement to Maintain: Prior to expiration of Contractor's warranty, submit a proposed "Agreement for Continued Service and Maintenance of Water Treatment Systems" to the Owner, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, including replacement of materials and equipment, for one-year periods with option to renew annually.

## PART 2 - PRODUCTS

### 2.01 CHEMICALS

- A. Manufacturers offering water treatment equipment that may be incorporated in the work include (but are not necessarily limited to) the following:
1. Sage Equipment Co.
  2. Morr Control
  3. Neptune

### 2.02 CHEMICALS

- A. Closed Water Systems: A buffered corrosion inhibitor shall be provided to initially treat the closed systems listed above. This treatment must contain steel and copper corrosion inhibitors and a polymer dispersant/scale inhibitor.
- B. Glycol:
1. A solution of water and inhibited propylene glycol shall be provided for the closed systems as listed herein. The glycol percentage by volume shall be as previously specified. Provide a minimum of 10% excess undiluted, inhibited propylene glycol in closed container(s) for Owner's future use.
  2. Approved product is Dow Chemical "Dowfrost."

- C. Cleaning Materials: Provide heavy duty cleaning materials as necessary to remove dirt and/or oily deposits from all new piping systems and/or equipment.
- D. Chemicals shall be acceptable to the EPA, state, and local agencies.

## 2.03 GLYCOL FEEDER SYSTEM

- A. Provide glycol feeder system(s) as indicated on the drawings.
  - 1. The glycol feeder shall be provided with pump(s) and controls for automatic injection of glycol solution into one closed systems.
  - 2. The glycol feeder shall have a 50 gallon fiberglass or polyethylene tank with capacity indication and removable hinged cover.
  - 3. The tank shall be supported by four steel legs with foot pads.
  - 4. Provide NPT 3/4 outlets on bottom of the tank for pump suction and drain valve connections. NPT 3/4 drain valve with hose bibb shall be provided for draining the tank.
- B. Provide one positive displacement all bronze rotary gear pump with a NPT 3/4 ball valve on the suction side, mounted on a platform beneath the tank.
  - 1. Pump shall operate at 1,725 rpm with a minimum capacity of 4 gpm @ 100 psig.
  - 2. Pump motor to be 1/3 hp, 120 volt/1 phase/60 Hz, UL listed with integral thermal overload protection.
- C. Pump discharge piping shall include a NPT 3/4 check valve, a NPT 3/4 "T" for connecting the glycol feeder to the system piping, and a relief valve(s) for discharge back into the storage tank (see drawings for set point).
- D. Furnish a prewired, tank-mounted control panel to provide for the following functions:
  - 1. System pressure switch for control of each pump, set at the required system fill pressure noted on drawings.
  - 2. System pressure readout gauge(s) (mounted on the face of the control panel)
  - 3. A low-level alarm switch with face-mounted alarm horn, low-level alarm light, and pushbutton horn silencer.
    - a. When the tank level is below a safe level, the alarm horn and light will activate.
    - b. The silencer switch (mounted on the front of the control cabinet) will silence the horn, but the low-level alarm light will remain on until the tank level has been refilled to a safe working level.
    - c. A clean set of form C dry contacts, wired to a terminal block, for remote annunciation of low-level alarm.
  - 4. Provide momentary spring-loaded pushbutton switch(es) on the face of the panel for testing the operation of each pump.
- E. The single-system glycol feeder shall be equivalent to Armstrong GLA-U-HP-1.
  - 1. The chosen product shall use a Furnas Electric Co., Model 69WA, for the pressure switch.

PART 3 - EXECUTION

3.01 CLEANING

A. Cleaning of Pipe Lines and Treating Water:

1. The water treatment vendor shall be responsible for furnishing the proper chemicals and supervising the cleaning of all HVAC water systems and providing specified treatment for such systems.
2. The systems to be cleaned shall first be flushed and then chemically cleaned per Division 23 Section "Common Work Results for HVAC." In closed systems with filter feeders, the filter shall be backwashed as required to remove solids that have been cleaned from the system. Dispose of the treatment water in accordance with state, federal and wastewater district regulations.
3. At the end of the cleaning period, the alkalinity of the system shall be reduced to that of the raw water and then the system shall be chemically treated as previously specified. In no case shall the system being cleaned be left in an untreated condition for more than 8 hours.
4. The water treatment contractor shall certify in writing that the system was cleaned and treated in conformance with the specifications.

**END OF SECTION**

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## SECTION 23 82 00 – CONVECTION UNITS

### PART 1 - GENERAL

#### 1.1 RELATED SECTIONS

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

#### 1.2 SUMMARY

- A. Section Includes: This section includes furnishing and installing HVAC water terminal units and specialties as shown on the drawings and as specified hereinafter.
  - 1. Fin tube radiation
  - 2. Cabinet unit heaters

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Submit product, dimensional, capacity, and performance data for all equipment and control items. Reference Division 23 Section "Common Work Results for HVAC" for additional requirements.
  - 2. Clearly mark or highlight the specific items being furnished. Indicate tag numbers where applicable.
- B. Shop Drawings: Submit shop drawings and specific or edited wiring diagrams for all electrically and/or gas-powered equipment.
- C. Close-out Submittals: Submit O&M data per Division 01 and Division 23 Section "Common Work Results for HVAC."

#### 1.4 QUALITY ASSURANCE

- A. All electrically operated equipment shall be UL listed and constructed to NEMA standards.
- B. Equipment capacities shall be rated according to Hydronics Institute (HYDI) standards.
- C. ASHRAE Compliance:
  - 1. Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
  - 2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air Conditioning."

### PART 2 - PRODUCTS

#### 2.1 HYDRONIC FIN TUBE RADIATION

- A. Approved Manufacturers: Slant Fin, Sterling, Vulcan, and Zehnder-Rittling.



B. Provide size, capacity, and type as scheduled and/or shown on the drawings.

C. Construction:

1. Copper tube element with aluminum fins, 150 psig working pressure rated
2. 16 -gauge enclosure with pencil proof louvers and flush joints
3. Manual damper with threaded damper screw and trunnion
4. 20-gauge Type A continuous back-plate
5. Wall-to-wall enclosures unless otherwise shown on the plans
6. End sections with access doors for access to valves, vents, etc.

D. Prime coat finish Color as selected by the Architect unless otherwise specified.

## 2.2 EXPANSION COMPENSATORS (RADIATION)

A. Approved Manufacturers: Hydroflex, Keflex, Metraflex, and Senior Flexonics HB.

B. Provide stainless steel bellows type expansion compensators (Keflex 11QTL or equal) where shown on the drawings or where required to meet expansion requirements.

C. Compensators shall be line size and have copper ends for sweat connections.

D. Each compensator shall provide for up to 1-inch total movement at working pressure up to 100 psig at 300°F maximum.

E. Provide expansion compensator pipe guides at recommended intervals, and anchor in accordance with expansion compensator manufacturer's recommendations.

## 2.3 CABINET UNIT HEATERS - HOT WATER

A. Approved Manufacturers: Airtherm, Armstrong, McQuay, Modine, Sterling, Trane, Vulcan, York, and Zehnder-Rittling.

B. Provide size, capacity, and type as scheduled and/or shown on drawings.

C. Coils shall have aluminum fins mechanically bonded to seamless copper tubing suitable for working pressures up to 150 psig hot water at 250°F maximum 30 psig steam at 300°F maximum.

D. Furnish heavy-gauge steel casing, phosphatized or galvanized for rust and corrosion prevention, and finished with baked-on enamel or epoxy powder-coat finish.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

1. Insulation in contact with airstream shall comply with ASTM C 1071, Type I or Type II.

F. Furnish open drip-proof totally enclosed explosion-proof, multi-speed permanent split capacitor motors with permanent lubrication, integral thermal overload protection, and vibration isolation.

G. Provide factory-balanced aluminum propeller fans with steel hubs and fan guard.

H. Furnish horizontal vertical double-deflection, individually adjustable discharge louvers.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Water Coil Piping Connections: Allow for coil removal without disrupting the piping and insulation. Provide shut-off valves, P&Ts, flow measurement and balancing valve, drain and air vent, and as further detailed on drawings.

#### 3.2 FIN TUBE INSTALLATION

- A. Finned elements shall be centered under windows wherever applicable.
- B. Enclosures shall be wall-to-wall or column-to-column unless otherwise shown on the plans.
- C. Provide access panels for access to all manual valves, flow measuring/balancing devices, and automatic control valves.
- D. Enclosure shall be made up of a minimum number of pieces. No short pieces shall be used where a longer piece would have minimized the number of pieces. Provide corner pieces where scheduled and/or indicated on plans.
- E. Provide anchors and expansion joints at locations shown on drawings. Install per manufacturer's recommendations.

#### 3.3 CABINET UNIT HEATERS - HOT WATER

- A. Install per manufacturer's recommendations. Furnish wall type brackets where shown and/or required.
- B. Provide manual air vent and P&T plugs vacuum breaker and shutoff valves for each unit heater.
- C. Adjust discharge louvers as required by location and/or application.

#### 3.4 FILTERS

- A. For units with filters, provide one set of filters during construction and start-up and one set of filters at beneficial occupancy.

**END OF SECTION 23 82 00**

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