

MEMORIAL HOSPITAL OF SWEETWATER COUNTRY LAUNDRY RENOVATION

1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901



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SECTION 01 1000 - SUMMARY

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Work by Owner.
 - 5. Access to site.
 - 6. Coordination with occupants.
 - 7. Work restrictions.
 - 8. Specification and Drawing conventions.
 - 9. Miscellaneous provisions.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.03 PROJECT INFORMATION

- A. Project Identification: MHSC Laundry Renovation.
 - 1. Project Location: 1200 College Drive, Rock Springs, Wyoming 82901.
- B. Owner: Memorial Hospital of Sweetwater Couty, 1200 College Drive, Rock Springs, Wyoming 82901.
- C. Engineer: Spacek Timbie and Blevins Engineering, Inc, 97 Main Street - Suite E-205, Edwards, Colorado 81632
- D. Engineer's Consultants: Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:
- E. Web-Based Project Software: Project software administered by Contractor will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Section 013100 "Project Management and Coordination." for requirements for administering and using web-based Project software.

1.04 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 - 1. Work for this project includes demolition, materials, labor, transportation, security, temporary construction and other items identified in, or reasonably inferable from the Construction Drawings and Project Manual and other Work indicated in the Contract Documents.
 - 2. The purpose of this project is to address aging laundry equipment, improve airflow, environmental control and equipment reliability in the laundry processing area, and establish a dedicated clean linen storage space outside the active laundry workflow.
- B. Type of Contract:
 - 1. Project will be constructed under a single prime contract.

1.05 PHASED CONSTRUCTION

- A. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates, and move-out and -in dates of Owner's personnel for all phases of the Work.

1.06 WORK BY OWNER

- A. General: The Owner is not performing any Work for this project. However, the Owner may have projects underway on Campus that are concurrent with this project. Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or other work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Concurrent Work: Owner will perform the following operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
 - 1. The Owner will maintain and operate Steam and Chilled water system. Required shutdowns will be jointly managed by contractor and owner for campus integrity.

1.07 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.08 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Be responsible to coordinate with the local Fire Department and maintain Fire Truck access acceptable to that Authority throughout the entire project duration.
 - 3. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.09 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7 a.m. to 5 p.m., Monday through Friday, unless otherwise indicated.
 - 1. Weekend Hours: Coordinate Weekend work with owner. Obtain Owner's written permission before proceeding.
 - 2. Hours for Utility Shutdowns: Coordinate with Owner.
 - 3. Hours for Core Drilling, Concrete Jackhammering, concrete sawing, steel cutting, miscellaneous noisy activities: Coordinate with owner.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Owner not less than two days in advance of proposed disruptive operations.
 - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Restricted Substances: Use of tobacco products and other controlled substances on Project site and entire Campus is not permitted.

- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

1.10 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations and scheduled on Drawings.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 011000

SECTION 01 2100 - ALLOWANCES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
- C. Related Requirements:
 - 1. Section 01 2600 - Contract Modification Procedures for procedures for submitting and handling Change Orders.
 - 2. Section 014000 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

1.03 DEFINITIONS

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.04 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Engineer from the designated supplier.

1.05 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.06 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.07 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Engineer under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.08 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable.
 - 1. Submit claims for increased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 - 2. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
 - 3. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.02 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.03 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Lump-Sum Allowance: Include the sum of \$35,000.00 (Thirty Five Thousand Dollars) for Costs associated with Black Hills Energy for the demolition of existing and installation of new gas services associated with this Project.

END OF SECTION 012100

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SECTION 01 2300 - ALTERNATES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

1.03 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Alternates Form (SC-6.13.1) for certain work defined in the bidding requirements that may be added to the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Bid Form Agreement.
 - 2. The cost for each alternate is the net addition to the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.04 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other work of the Contract.
- C. Schedule: A schedule of alternates is included at the end of this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SCHEDULE OF ALTERNATES

- A. Add Alternate No. 1 (A.A. No. 1): Tunnel Construction From Alley Vault to Illinois Street.
 - 1. Base Bid: Construct tunnel with piping along 18th street with Steam, Condensate and chilled water piping with Vault near Alley.

2. Add Alternate : Construct tunnel, steam piping, condensate piping, chilled water piping from vault to Illinois Street.

END OF SECTION 012300

SECTION 01 2500 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 012300 "Alternates" for products selected under an alternate.
 - 2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.03 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 Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.04 ACTION SUBMITTALS

- A. Substitution Requests During the Bid Phase: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use CSI Form 1.5C.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions 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 as well as 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 substitutions 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. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven 7 days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven 7 days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.05 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.

1.06 PROCEDURES

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

1.07 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
- B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after commencement of the Work . Requests received after that time may be considered or rejected at discretion of Engineer.
1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
 - j. 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 012500

SECTION 01 2600 - CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 01 2500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.03 MINOR CHANGES IN THE WORK

- A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 .

1.04 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail." .

- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Engineer.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - 6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 - 7. Proposal Request Form: Use Proposal Request Form: Use CSI Form 13.6A, "Change Order Request (Proposal)," with attachments CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, Proposal Worksheet Detail. .

1.05 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on AIA Document G701 .

1.06 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Engineer may issue a Construction Change Directive on AIA Document G714 . Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 012600

SECTION 01 2900 - PAYMENT PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.03 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.

1.04 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule. Cost-loaded Critical Path Method Schedule may serve to satisfy requirements for the schedule of values.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Engineer at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 - 3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
 - 4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
- 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 Engineer.
 - c. Engineer's Project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
2. Arrange schedule of values consistent with format of AIA Document G703 .
3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of 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.
6. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
7. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
8. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
9. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.05 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 Engineer and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

1. Other Application for Payment forms proposed by the Contractor shall be acceptable to Engineer and Owner. Submit forms for approval with initial submittal of schedule of values.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. 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 and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 1. Provide certificate of insurance, evidence of transfer of title to Owner, 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.
- F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
 1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.

4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 5. Products list (preliminary if not final).
 6. Sustainable design action plans, including preliminary project materials cost data.
 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.
 15. Certificates of insurance and insurance policies.
 16. Performance and payment bonds.
 17. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: After 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 Owner occupancy of designated portions of the Work.
- J. 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. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706.
 5. AIA Document G706A.
 6. AIA Document G707.
 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 Owner took possession of and assumed responsibility for corresponding elements of the Work.

9. Final liquidated damages settlement statement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 012900

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SECTION 01 3100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.01 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.

1.02 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. RFIs.
 - 4. Digital project management procedures.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.03 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.04 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. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address 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 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and 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. Post copies of list in project meeting room, in temporary field office, and in prominent location in each built facility. Keep list current at all times.

1.05 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. 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.

1.06 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated 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 coordination drawings by multiple contractors 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 Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to 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. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 2. 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.
 3. 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.
 4. Review: Engineer will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Engineer will so inform Contractor, who shall make suitable modifications and resubmit.
 5. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format PDF format.

2. Engineer will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.

1.07 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 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 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.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Engineer.
 1. Attachments shall be electronic files in PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer's response for each RFI. RFIs received by 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 Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 - 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
 - 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.
 - E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly . Use software log that is part of web-based Project software. Include the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Engineer.
 - 4. RFI number including RFIs that were returned without action or withdrawn.
 - 5. RFI description.
 - 6. Date the RFI was submitted.
 - 7. Date Engineer's response was received.
 - 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
 - F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.
- 1.08 DIGITAL PROJECT MANAGEMENT PROCEDURES
- A. Engineer's Data Files Not Available: Engineer will not provide Engineer's CAD drawing digital data files for Contractor's use during construction.
 - B. Use of Engineer's Digital Data Files: Digital data files of Engineer's CAD drawings will be provided by Engineer for Contractor's use during construction.
 - 1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
 - 2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 - C. Web-Based Project Software: Provide, administer, and use web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.
 - 1. Web-based Project software site includes, at a minimum, the following features:

- a. Compilation of Project data, including Contractor, subcontractors, Engineer, Engineer's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 2. Provide up to seven web-based Project software user licenses for use of Owner, Owner's Commissioning Authority, Engineer, and Engineer's consultants. Provide 0 hours of software training at Engineer's office for web-based Project software users.
 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Engineer. Provide data in locked format to prevent further changes.
 4. Provide one of the following web-based Project software packages under their current published licensing agreements:
 - a. Autodesk.
 - b. Corecon Technologies, Inc.
 - c. Meridian Systems; Prolog.
 - d. Newforma, Inc.
 - e. Procore Technologies, Inc.
 - f. Viewpoint, Inc.; Viewpoint for Project Collaboration.
- D. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare 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.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.09 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 Owner and Engineer of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
 - 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 Owner and Engineer, within three days of the meeting.
- B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
 - 1. Attendees: Authorized representatives of Owner , Owner's Commissioning Authority, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Sustainable design requirements.
 - o. Preparation of Record Documents.
 - p. Use of the premises and existing building.
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - x. Parking availability.
 - y. Office, work, and storage areas.
 - z. Equipment deliveries and priorities.
 - aa. First aid.

- bb. Security.
 - cc. Progress cleaning.
- 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
 - 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer, and Owner's Commissioning Authority of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.
 - 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, 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.
 - 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 Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - 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. Preparation of Contractor's punch list.
 - j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - k. Submittal procedures.
 - l. Coordination of separate contracts.
 - m. Owner's partial occupancy requirements.
 - n. Installation of Owner's furniture, fixtures, and equipment.
 - o. 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: In addition to representatives of Owner, Owner's Commissioning Authority, Construction Manager, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 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: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Status of sustainable design documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site use.
 - 10) Temporary facilities and controls.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of Proposal Requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Attendees: In addition to representatives of Owner , Owner's Commissioning Authority and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
- c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of RFIs.
 - 14) Proposal Requests.
 - 15) Change Orders.
 - 16) Pending changes.
- 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013100

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SECTION 01 3200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 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.

1.02 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. Material location reports.
 - 6. Site condition reports.
 - 7. Unusual event reports.

1.03 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 completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- 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 Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.04 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
1. Working electronic copy of schedule file, where indicated.
 2. PDF file.
- B. Startup construction schedule.
1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
 3. Total Float Report: List of activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work the Notice to Proceed until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.
- H. Material Location Reports: Submit at weekly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Unusual Event Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.05 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Engineer's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "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 Owner occupancy.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner'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 Owner startup procedures , including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.06 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.

1.07 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion .
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each floor 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 30 days, unless specifically allowed by Engineer.

2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. Pre-insulated Piping.
 - b. Chiller
 - c. Cooling Tower
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Commissioning Time: Include no fewer than 15 days for commissioning.
 6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
 7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use-of-premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 3. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.

4. Construction Areas: 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.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion .
 1. Temporary enclosure and space conditioning.
- F. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
 1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- G. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- H. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- I. 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, equipment required to achieve compliance, and date by which recovery will be accomplished.
- J. Distribution: Distribute copies of approved schedule to Engineer Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.08 STARTUP CONSTRUCTION SCHEDULE

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

1.09 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed .
 - 1. 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.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.10 CPM SCHEDULE REQUIREMENTS

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed . Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for the Notice to Proceed .
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.
 - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and inspection.
 - j. Commissioning.
 - k. Punch list and final completion.
 - l. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Engineer's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Engineer.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.

8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.
- 1.11 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. Testing and inspection.
 8. Accidents.
 9. Meetings and significant decisions.
 10. Unusual events.
 11. Stoppages, delays, shortages, and losses.
 12. Meter readings and similar recordings.
 13. Emergency procedures.
 14. Orders and requests of authorities having jurisdiction.
 15. Change Orders received and implemented.

16. Construction Change Directives received and implemented.
 17. Services connected and disconnected.
 18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Material Location Reports: At weekly 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.
- C. 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.
- D. Unusual Event Reports: 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, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013200

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SECTION 01 3233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 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.

1.02 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 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
 - 4. Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.03 INFORMATIONAL SUBMITTALS

- A. 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.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in web-based project software site:
 - a. Name of Project.
 - b. Date photograph was taken.
 - c. Description of location, vantage point, and direction.
 - d. Unique sequential identifier keyed to accompanying key plan.

1.04 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.

- B. Web-Based Photographic Documentation Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project.

1.05 FORMATS AND MEDIA

- A. Digital Photographs: Provide color 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 , and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- C. Metadata: Record accurate date and time and GPS location data from camera.
- D. File Names: Name media files with date Project area and sequential numbering suffix.

1.06 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Preconstruction Photographs: Before commencement of excavation commencement of demolition starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.
 - 1. Flag excavation areas construction limits before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Periodic Construction Photographs: Take 20 photographs monthly . Select vantage points to show status of construction and progress since last photographs were taken.
- D. Final Completion Construction Photographs: Take 50 photographs after date of Substantial Completion for submission as Project Record Documents. Engineer will inform photographer of desired vantage points.
- E. Additional Photographs: 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 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. Substantial Completion of a major phase or component of the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013233

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SECTION 01 3300 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Submittal schedule requirements.
 - 2. Administrative and procedural requirements for submittals.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
 - 3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
 - 5. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
 - 6. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
 - 7. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 8. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 9. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.03 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require 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."

1.04 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list 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 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. Include submittals required during the first 60 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 Engineer's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.05 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
 2. Date.
 3. Name of Engineer.
 4. Name of Contractor.
 5. Name of firm or entity that prepared submittal.
 6. Names of subcontractor, manufacturer, and supplier.
 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
 8. Category and type of submittal.
 9. Submittal purpose and description.
 10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 11. Drawing number and detail references, as appropriate.
 12. Indication of full or partial submittal.
 13. Location(s) where product is to be installed, as appropriate.

14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

- B. Options: Identify options requiring selection by Engineer.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- E. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

1.06 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Email: Prepare submittals as PDF package, and transmit to Engineer by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer.
 - a. Engineer will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 2. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. 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 submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on 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 (10) consecutive working days from when submittal is received by design team for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination. Additional days will be required for the review of any shop drawings and other submittals requiring review by the design team if received in quantity equal to or less than fifty (50) sheets during five (5) consecutive working days. For each sheet or other item in excess of over fifty (50) sheets received in five (5) consecutive working days, additional time will be required for review time. The Architect will advise the Contractor of additional time required.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow (10) consecutive working days from when submittal is received by design team for review of each resubmittal.
 4. Concurrent Consultant Review: Where concurrent review of submittals by Architect's consultants, Owner, or other parties is required, allow twenty (20) working days for initial review of each submittal.
 5. No extension of the Contract Time will be authorized because of:
 - a. Failure to comply with approved Submittal Schedule.
 - b. Failure to transmit submittals enough in advance of the Work to permit processing.
- D. 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 Engineer's action stamp.
 4. Resubmittals shall include complete submittal information regardless if certain items within the previous submittal did not require a resubmittal. Partial resubmittals are not acceptable. The resubmittal shall serve as a complete consolidated submittal of all items being provided.
 5. Engineer review of shop drawings include up to (1) resubmittal of the initial submittal. Engineer reserves the right to bill for additional review time at current hourly rates for any additional resubmittals. Contractor shall be responsible for any additional expenses due to additional review / resubmittal efforts by the Engineer.
- E. 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.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.
- 1.07 SUBMITTAL REQUIREMENTS
- A. 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 unsuitable 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. Testing by recognized testing agency.
 - d. Notation of coordination requirements.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. 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.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. 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 Owner's property, are the property of Contractor.
 6. 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. Engineer will return submittal with options selected.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- E. 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.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 1. Certificates and Certifications Submittals: Submit 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. Provide a notarized signature where indicated.
 2. 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.
 3. 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.
 4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
 6. 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.
- H. Test and Research Reports:
 1. 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.

2. 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.

1.08 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 insufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file 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.
 2. Where design calculations are requested, submit copies of calculations sealed and signed by the design professional responsible for their preparation concurrently with related system shop drawings.
 3. 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.

1.09 CONTRACTOR'S REVIEW

- A. Action Submittals 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 Engineer.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project software. Include 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.
 1. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ENGINEER'S ACTION

- A. Action Submittals: Engineer will review each submittal, indicate corrections or revisions required, and return it.
 1. PDF Submittals: Engineer will indicate, via markup on each submittal, the appropriate action .
 2. Submittals by Web-Based Project Software: Engineer will indicate, on Project software website, the appropriate action.

- B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. 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 Engineer.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Engineer will return without review submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Engineer without action.
- G. Submittal review is only for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. Corrections or comments made during the review does not relieve the Contractor from compliance with requirements of the Drawings and Specifications. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his/her work with that of all other trades; and performing his/her work in a safe and satisfactory manner. The submittal review does not modify the Contractor's duty to comply with the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013300

SECTION 01 3516 - ALTERATION PROJECT PROCEDURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes special procedures for alteration work.

1.03 DEFINITIONS

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the Engineer's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Engineer.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep existing items that are not to be removed or dismantled.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

1.04 COORDINATION

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.
1. Schedule construction operations in sequence required to obtain best Work results.
 2. Coordinate sequence of alteration work activities to accommodate the following:
 - a. Owner's continuing occupancy of portions of existing building.
 - b. Owner's partial occupancy of completed Work.
 - c. Other known work in progress.
 - d. Tests and inspections.
 3. Detail sequence of alteration work, with start and end dates.
 4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 5. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project building(s) and site. Some work is near circulation patterns and adjacent to restricted areas . Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

1.05 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site .
1. Attendees: In addition to representatives of Owner, Engineer, and Contractor, testing service representative, specialists, and chemical-cleaner manufacturer(s) shall be represented at the meeting.
 2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
 - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of alteration work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Qualifications of personnel assigned to alteration work and assigned duties.
 - j. Requirements for extent and quality of work, tolerances, and required clearances.

- k. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.
 - 3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 - 1. Attendees: In addition to representatives of Owner, Engineer, and Contractor, each specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of alteration work activities shall be represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to alteration work.
 - 2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
 - a. Alteration Work Subschedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
 - b. Schedule Updating: Revise Contractor's Alteration Work Subschedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Conference for Alteration Work" Paragraph in this article and the following:
 - 1) Interface requirements of alteration work with other Project Work.
 - 2) Status of submittals for alteration work.
 - 3) Access to alteration work locations.
 - 4) Effectiveness of fire-prevention plan.
 - 5) Quality and work standards of alteration work.
 - 6) Change Orders for alteration work.
 - 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.06 INFORMATIONAL SUBMITTALS

- A. Alteration Work Subschedule:
 - 1. Submit alteration work subschedule within seven 30 days of date established for commencement of alteration work .
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.
- C. Fire-Prevention Plan: Submit 30 days before work begins.

1.07 QUALITY ASSURANCE

- A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and extent to alteration work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
 - 1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
- B. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- C. Safety and Health Standard: Comply with ANSI/ASSE A10.6.

1.08 STORAGE AND HANDLING OF SALVAGED MATERIALS

- A. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Engineer, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
- B. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
 - 1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 - 2. Secure stored materials to protect from theft.
 - 3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F or more above the dew point.

1.09 FIELD CONDITIONS

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of measured drawings preconstruction photographs and .
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- B. Discrepancies: Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.

PART 2 PRODUCTS - (NOT USED)

PART 3 EXECUTION

3.01 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
 - 1. Use only proven protection methods, appropriate to each area and surface being protected.
 - 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
 - 3. Erect temporary barriers to form and maintain fire-egress routes.
 - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
 - 5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
 - 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 - 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
 - 8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
 - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Engineer immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
 - 1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
 - 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

3.02 PROTECTION FROM FIRE

- A. General: Follow fire-prevention plan and the following:
 - 1. Comply with NFPA 241 requirements unless otherwise indicated. Perform duties titled "Owner's Responsibility for Fire Protection."
 - 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.

- a. If combustible material cannot be removed, provide fire blankets to cover such materials.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
 1. Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
 2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
 3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
 4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
 5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
 6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
 - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
 - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
 - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire-watch personnel at each area of Project site until 60 minutes after conclusion of daily work.
- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

3.03 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents

or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.

- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.04 GENERAL ALTERATION WORK

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs . Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify Engineer of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the work in question until directed by Engineer.

END OF SECTION 013516

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SECTION 01 4000 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.03 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described 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.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. 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, assembly, 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).
- D. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency

qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

- E. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- F. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- G. 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.
- H. 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. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.04 CONFLICTING REQUIREMENTS

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

1.05 ACTION SUBMITTALS

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

1.06 INFORMATIONAL SUBMITTALS

- A. 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.

- B. Reports: Prepare and submit certified written reports and documents as specified.
- C. Permits, Licenses, and Certificates: For Owner's record, 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.

1.07 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
1. Project quality-control manager may also serve as Project superintendent .
 2. .
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 3. Owner-performed tests and inspections indicated in the Contract Documents , including tests and inspections indicated to be performed by Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.08 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, telephone number, and email address 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 inspection.
 - 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, telephone number, and email address 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, telephone number, and email address 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.

1.09 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

- 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. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- 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. **Installer Qualifications:** A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **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. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329 ; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- G. **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.
- H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.10 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - 2. 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 Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 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. Engage a qualified testing agency to perform quality-control services.
 3. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 5. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 6. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. 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.
- D. Testing Agency Responsibilities: Cooperate with Engineer , Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer , Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations 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 duties of Contractor.
- E. 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 013300 "Submittal Procedures."
- F. 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.
- G. Associated Contractor Services: Cooperate with agencies and representatives 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 inspection. Assist agency in obtaining samples.

4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. 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 Owner, Engineer, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Engineer, Commissioning Authority, 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 Engineer and Commissioning Authority 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.
 7. .

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEST AND INSPECTION LOG

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

- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's, Commissioning Authority's, reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.02 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, 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 017300 "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.

END OF SECTION 014000

SECTION 01 4200 - REFERENCES

PART 1 GENERAL

1.01 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.

1.02 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.03 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1.04 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 indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- 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. This information is believed to be accurate as of the date of the Contract Documents.
 - 1. DIN - Deutsches Institut für Normung e.V.; www.din.de.
 - 2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 - 3. ICC - International Code Council; www.iccsafe.org.
 - 4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
- C. 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. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
 - 1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
 - 2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
 - 3. DSCC - Defense Supply Center Columbus; (See FS).
 - 4. FED-STD - Federal Standard; (See FS).
 - 5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
 - 6. MILSPEC - Military Specification and Standards; (See DOD).
 - 7. USAB - United States Access Board; www.access-board.gov.
 - 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 014200

SECTION 01 3533 - INTERIM INFECTION CONTROL MEASURES (IICM)

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

- A. The Engineer has designated this project to require Interim Infection Control Measures – Class III for the work outside of the mechanical room. In the mechanical room this project requires Interim Infection Control Measures – Class II.
- B. Healthcare-associated infections of immuno-compromised patients, staff and visitors may be caused by exposure to airborne contaminants.
 - 1. Construction, renovation and repair activities may generate suspended fungal spores and/or bacterial contaminants from dust, debris and earthwork excavation dust.
 - 2. Fungal spores can be carried by air currents to remote locations within a facility.
 - 3. Control of airborne contaminants in smoke, construction dust, debris and excavation dust as required by this Section is imperative.
- C. Interim Infection Control Measures (IICM) shall provide an appropriate level of safety when there are conditions that increase the risk of healthcare-associated infections.
- D. The Owner may provide baseline particle counts and conduct periodic air sampling of protection areas during construction to monitor effectiveness of IICM.
- E. The Contractor shall comply with applicable codes and use installation procedures and methods that satisfy applicable code requirements and procedures.
- F. The Contractor shall verify the maintenance of negative air pressure in containment area relative to protection areas on a continuous basis by use of differential pressure monitors.
- G. If the Contractor fails to maintain infection control procedures:
 - 1. The Owner may issue written warning or Non-conformance Notice.
 - 2. The Contractor shall correct non-conformance immediately.
 - 3. If situation is not corrected within eight (8) hours of receipt of warning or Non-conformance Notice, the Owner will have cause to stop Work as provided in Contract Documents at no additional cost to the Owner.
 - 4. Failure of the Contractor to correct deficiencies may result in corrective action taken by the Owner and deducting all cost associated with from Contract Amount.
- H. If mold or asbestos are discovered during construction operations, the Contractor shall stop work immediately in the area and notify the Owner's Representative.
- I. The Owner's Representative shall be notified daily (within the first hour of work) of all sick employees working on the project. Employees that are sick (such as diarrhea, upper respiratory infection and fever) and working, shall wear personal protective equipment (PPE) such as a surgical mask.

1.02 DEFINITIONS

- A. Airborne contaminant producing activities include, but are not limited to:
 - 1. Demolition and removal of walls, floors, ceilings, and other finish materials.
 - 2. Demolition of plumbing, mechanical and electrical systems and equipment.
 - 3. Finish operations such as sanding, painting, and application of special surface coatings.
 - 4. All other construction activity that may generate dust, smoke or fumes.
- B. Primary Containment Area: The largest area of project work around which temporary dust partitions are built.
- C. Secondary Containment Area: Areas of Work within the Protection Area outside of the Primary Containment Area that requires a form of dust control.
- D. Protection Areas: Interior occupied areas within facilities, which are adjacent to a Primary Containment Area, either occupied or used for passage, as well as areas connected to construction area by mechanical system air intake, exhaust and ductwork.
- E. Preparation Area: specific area located as designated by the Owner's Representative for donning and removing protective clothing prior to entering the Containment Area.

1.03 SUBMITTALS

- A. Project Information:
 - 1. Submit drawings indicating Work areas and procedure for containment of airborne contaminants for the Owner's review and approval.
 - a. Indicate locations of temporary enclosures, barriers, isolation vestibules, negative air machines, exhaust fans, capped ductwork and airflow direction indicator.
 - b. Drawings shall indicate, as a minimum, containment areas, protection areas, enclosure types, vestibules, location of negative air machines, capped ductwork.
 - 2. Specific means and methods of achieving and maintaining control of airborne contaminants during construction for Owner's review and approval.
 - 3. Submit Daily inspection reports, noting employees that are ill, on a weekly basis to the Owner's Representative.
 - 4. Submit copy of HEPA/ULPA vacuum DOP (Dispersed Oil Particulate) test conducted by an independent testing agency, dated within the past six (6) months.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. HEPA/ULPA, Ultra-Low Penetration Air vacuum cleaners:
 - 1. HEPA/ULPA vacuum shall trap 99.999% of particles 0.12 microns and larger. Vacuum shall have a minimum air flow of 90 cfm.
 - 2. Acceptable products:
 - a. ISC Sales "Minuteman Model CRV - 99.999%"
 - b. Nilfisk Advance
 - c. Pro-Team "Vacer HEPA/ULPA Vacuum"
 - d. Design Professional approved equivalent

- B. Polyethylene: 6 mil or 8 mil thick reinforced laminated polyethylene film; shall meet requirements of NFPA 701 large scale flammability test and ASTM E84 Class A.
 - 1. Include compatible fire retardant tape.
 - 2. Acceptable products:
 - a. Tri Synergy Flexible Film "Surface Cover" (tel: 800.446.6076).
 - b. American Cover "Surface Cover" (tel: 800.747.6095).
 - c. Reef Industries "Griffolyn Type 55 FR" (tel: 800.231.6074).
 - d. Design Professional approved equivalent
- C. Adhesive-Faced Contamination Control Mats (sticky walk-off mats):
 - 1. Size of mats shall be the width of the opening and 30" (minimum) depth.
 - 2. Acceptable products:
 - a. ASG "Walk-off Mats" (tel: 216.486.6163).
 - b. Controlled Environment Equipment "Cleanline Sticky Mat" (tel: 800.569.5444).
 - c. Liberty Industries "Tacky Mat" (tel: 800.246.7483).
 - d. Curtain Wall Company "CleanStep" tacky mats (tel: 800.424.8251)
 - e. Design Professional approved equivalent
- D. Negative Air Machine: A machine with a fan or blower, typically with HEPA/ULPA filters, which is able to negatively pressurize a room or area for a continuous period of time. Provide unit sized to meet room requirements. If unit does not exhaust air to the outside of the building, provide additional carbon filtering.
 - 1. Units shall include prefilters, final filters, HEPA/ULPA-filters and filter static pressure gauges.
 - 2. HEPA/ULPA filters shall be 99.997% efficient at 0.3 micron particle size.
 - 3. Acceptable manufacturers:
 - a. Abatement Technologies
 - b. Phoenix
 - c. Dri-Eaz
 - d. Micro-Trap, Inc.
 - e. Control Resource System Inc
 - f. NIKRO Industries, Inc.
 - g. Design Professional approved equivalent.
- E. Zipper Lock Entrance:
 - 1. Fire retardant, reinforced vinyl construction with reinforced stitching. Acceptable products:
 - a. Curtain Wall Company "Dust-Door" (tel: 800.424.8251)
 - b. Pro Venture Inc "Zip-Up" (tel: 978.744.5000)
 - c. Design Professional approved equivalent
- F. Temporary Prefabricated Enclosure Units:
 - 1. Provide the enclosure with an inspection window and pressure differential porthole.
 - 2. Acceptable products:
 - a. Fiberlock Technologies "Kontrol Kube" with frame #6440, enclosure #6442, wheel base platform #6443 and Milfish 87 cfm vacuum device and manometer.
 - b. Specialty Tool Manufacturing "MCU – Quick Wall Mobile Containment Unit"; provide with HEPA/ULPA vacuum connection (tel: 888.718.3878).
 - c. Mintie Technologies "ECU EnterRoom Envelope"

- d. Design Professional approved equivalent
- G. Airflow Direction Indicator:
 - 1. Acceptable products:
 - a. Airflow Direction Inc. “ADI-69-V-N” (tel: 888.334.4545)
 - b. Austin Ventrues “Model LN102” (tel: 909.043.8172)
 - c. Design Professional approved equivalent
- H. Dust Catching Device:
 - 1. Disposable, dry, electrostatic cloths or mitts for dust removal.
 - 2. Disposable, wet cloths, presoaked with cleaning solution, for dust removal.
 - 3. Acceptable products:
 - a. Proctor & Gamble “Swiffer Dry”, “Swiffer Mitt” or “Swiffer Wet”
 - b. Reckitt Benckiser “Mop & Glo”
 - c. S.C. Johnson & Sons “Pledge Grab It”
 - d. Design Professional approved equivalent.

PART 3 - EXECUTION

3.01 GENERAL

- A. All barriers visible to patients and/or the general public shall be hard painted barriers.
- B. The Owner’s Representative will make regular visits to the project site to ensure compliance of policy. The Owner reserves the right to inspect the work at any time to verify that the Contractor is complying with these infection control requirements.
- C. Notify the Owner’s Representative at least fourteen (14) calendar days prior to preparing a containment area or starting work activity outside of the containment area or in Owner occupied spaces.
- D. Instruct the Contractor’s personnel to refrain from tracking dust into adjacent areas or opening windows or doors that would allow airborne contaminants into adjacent hospital areas.
- E. For exterior work, direct exhaust from equipment away from building air intakes, windows and doors. Ensure that filters on building air intakes are operational and protected from excessive quantities of airborne contaminants.
- F. Workers shall wear clean clothing and footwear.
- G. Disposable protective clothing shall be replaced if torn or dirty. Washable protective clothing shall be washed when dirty or weekly, as a minimum.

3.02 CLEANING - GENERAL

- A. Maintain Containment Area free of waste materials, debris and rubbish. Maintain site in clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums and other closed or remote spaces, prior to enclosing the space.

- C. Clean interior areas using HEPA/ULPA vacuum prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Remove waste materials, debris and rubbish from the site daily and dispose of off site.

3.03 STANDARD OPERATION PROCEDURES FOR CLASS I AREAS

- A. Operation in Class I Areas:
 - 1. Execute work by methods to minimize raising dust from construction operations.
 - 2. Immediately replace ceiling tile displaced for visual inspection.
 - 3. Wet mop and/or HEPA/ULPA vacuum before leaving area.

3.04 STANDARD OPERATION PROCEDURES FOR CLASS II AREAS

- A. Preparation and Operation of Class II Areas:
 - 1. Water misting of work surfaces is not permitted except for cleaning debris carts and work surfaces.
 - 2. To contain dust and debris, duct tape doors for demolition and/or construction activities that produce large amounts of dust or utilize "work enclosures".
 - 3. Block off and seal HVAC supply, return and exhaust terminal, registers, grilles and diffusers in the rooms affected by construction.
 - 4. Masks are optional by the person doing the cutting.
 - 5. Holes cut or punctured in walls and partitions, ceilings, floors and doors cannot be left exposed longer than four (4) hours. If work cannot be completed within the four (4) hour time period, the holes shall be covered.
- B. Flooring removal in Class II Secondary Containment areas
 - 1. Construction materials and equipment shall be stored within designated areas.
 - 2. Only flooring area of a size that can be removed, replaced and completed in one work period shall be worked on.
 - 3. Removal of flooring:
 - a. Vacuum carpet before removal with a HEPA/ULPA vacuum.
 - b. Damp mop sheet vinyl and vinyl composition tile flooring.
 - c. Use motions and methods that minimize the dispersing of dust and debris while removing flooring.
 - d. HEPA/ULPA vacuum floor after removal of flooring, adhesive and leveling of area prior to installation of new flooring.
- C. Clean-up of Class II areas:
 - 1. At the completion of the work, the following shall occur:
 - a. Clean work surfaces and debris carts with water.
 - b. Contain construction waste before transport in clean, tightly covered containers or sealed plastic bags.
 - c. Wet mop and/or vacuum with HEPA/ULPA-filtered vacuum before leaving the work area.
 - d. Remove isolation of HVAC system in areas where work is being performed.

3.05 STANDARD OPERATION PROCEDURES FOR CLASS III AREAS

A. Preparation of Class III Areas:

1. Determine in coordination with the Owner's Representative the location of pathways to the Containment Area and the Entry and Exit locations into the Containment Area.
2. The Contractor shall completely install all infection control measures before the balance of the Work begins. Dust barriers shall be set up around the specific areas of the project.
 - a. Provide temporary barriers and ceilings to separate work areas (Containment Areas) from Owner-occupied areas (Protection Areas) and to prevent penetration of dust into Owner-occupied areas.
 - b. Barriers to be constructed of temporary framing supports and fire-retardant polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces.
 - c. Doors located in temporary polyethylene partitions shall be zipper type attached to the polyethylene sheet material.
 - d. Seal all penetrations of the temporary partitions with duct tape as necessary to maintain the dust containment and the fire rating of the partition
 - e. The dust barriers shall be partitions from the ceiling to floor, completely enclosing the Containment Area.
 - f. The dust barriers shall remain around the selected construction area until that specific work has been satisfactorily completed.
3. Provide adhesive-faced contamination control mats at the construction entry point on both sides of the temporary partition. Workers shall step on both mats when exiting a containment area. Carts shall be moved across both mats.
4. Provide the necessary quantity of negative air machines to maintain each separate project work area at a negative pressure with respect to the patient care areas to control the spread of contaminants from the Containment Areas to adjacent Protection Areas.
 - a. Negative air pressure machines equipped with high efficiency particulate (HEPA/ULPA) filters shall be used in conjunction with a sealed work area to maintain a negative pressure inside the work area relative to non-work areas.
 - 1) A sufficient quantity of negative pressure ventilation units equipped with filtration shall be utilized to provide one workplace air change every 15 minutes. This requirement shall apply to the removal of the dust and contaminants from the air.
 - 2) To calculate total air flow requirement: $\text{Total cubic feet/minute} = \text{volume of work area (in cubic feet)} \div 15 \text{ minutes}$.
 - 3) To calculate the quantity of units needed for the dust control in a specific work area: $\text{Quantity of units needed} = \text{total cubic feet/minute} \div \text{capacity of a unit in cubic feet/minute}$.
 - 4) The total quantity of negative air machines required is dependent upon the total quantity of simultaneous containment areas being occupied by the Contractor. Refer to the plans to calculate the quantity of negative air machines required assuming the construction barriers indicated on the drawings.
 - 5) Connect the negative air machine discharge to the existing building return or exhaust system if indicated by the Mechanical Drawings.
 - 6) Change dust filter media as needed for the negative air machines.
 - b. Make-up air for the air exhausted from the spaces shall be taken from the existing HVAC system.

- c. Negative air machines shall be connected to emergency power and run continuously.
 - d. Vent negative air machines to outside by removing existing windows and replacing them with vented panels having fittings for exhaust holes.
 - e. Change filters as frequently as recommended by the manufacturer for duration of Work within the Containment Area to maintain a negative pressure of 0.1 - 0.2 IN of water gauge.
 - f. Negative air units shall be DOP tested and certified prior to being placed in service, and when dropped, damaged or moved extensively.
- 5. Each phase of construction shall be considered a separate area.
- 6. Duct Caps: Block off all existing return, exhaust and supply air ductwork within the Containment Area by capping ducts to withstand airflow, and so they are dust tight.
- B. Operation in Class III Areas:
 - 1. The containment control mats shall be monitored and replaced as they become loaded with dirt.
 - 2. The dust partitions shall be wiped down daily with a moist cloth or dust catching device.
 - 3. Traffic between containment areas and protection areas shall be kept to a minimum.
 - 4. Keep doors into containment areas closed at all times.
 - 5. All vacuuming of area outside of the work area not within the barriers shall be done by the Contractor with HEPA/ULPA vacuums.
 - 6. All holes, pipes, conduit, punctures and exposures shall be sealed appropriately.
 - 7. Removal of debris from the project work areas shall be as follows:
 - a. If debris is removed from the project site through an occupied Patient Care Area (Protection Area), the following procedure shall be followed:
 - 1) Removal of debris shall be done by the Contractor. The Contractor shall advise the Owner's Representative when there is debris to be removed. Debris shall be removed on an "as needed" basis. Transport removed material in tightly sealed, rubber tired containers provided by the Contractor to protect Protection Areas. The Owner's Representative will review the type of cart and condition of the cars proposed for use. Containers shall be fitted with clean, tight fitting plastic cover or polyethylene covers, completely sealed at perimeters by taping. Before leaving the Containment Area all containers shall be wiped or HEPA/ULPA vacuumed clean to prevent tracking of dust. The cart shall be rolled over the adhesive faced contamination control mats inside and outside the entrances.
 - 2) Place covers over debris boxes between periods when they are being filled.
 - b. Supplies and tools shall be brought into the Containment Area in accordance with the following procedure:
 - 1) For tools and supplies moved to the Containment Area the following procedures shall apply:
 - a) Tools and supplies shall be wiped clean or wrapped in plastic sheeting and moved by Contractor provided rubber tired carts/containers, from a staging area to the containment area (construction site).
 - b) The containers shall be vacuumed with HEPA/ULPA vacuum cleaners by the Contractor prior to moving through the occupied space to the Containment Area. The Contractor shall notify the Owner's Representative of the need to move these containers through Protection Areas prior to entering the Containment Area.

- c) Tool and supply removal from the Containment Area shall follow the procedure specified for debris removal from the Containment Area.
- 8. The following procedure shall be implemented when construction personnel are required to pass through a Protection Area to enter a Containment Area:
 - a. Personnel shall don protective clothing required by the Owner's Representative within the Preparation Area before passing through Protection Areas.
 - b. Protective clothing shall be removed upon entering the Containment Area and shall be stored in plastic bags.
- 9. The following procedure shall be implemented when construction personnel are required to pass from a Containment Area through a Protection Area:
 - a. Construction workers shall vacuum themselves with the HEPA/ULPA filtered vacuum cleaners. After being vacuumed the workers shall re-don protective clothing before re-entering the Protection Area
 - b. Personnel shall remove the protective clothing in the Preparation Area.
 - c. All dust and debris tracked outside the Containment Area shall be vacuumed up immediately by the Contractor.
- C. Flooring removal in Class III Secondary Containment areas
 - 1. Construction materials and equipment shall be stored within designated areas.
 - 2. Only flooring area of a size that can be removed, replaced and completed in one work period shall be worked on.
 - 3. Removal of flooring:
 - a. Vacuum carpet before removal with a HEPA/ULPA vacuum.
 - b. Damp mop sheet vinyl and vinyl composition tile flooring.
 - c. Use motions and methods that minimize the dispersing of dust and debris while removing flooring.
 - d. HEPA/ULPA vacuum floor after removal of flooring, adhesive and leveling of area prior to installation of new flooring.
- D. Miscellaneous work activities which is required within existing ceiling spaces in a protection area which can be confined shall be performed as follows:
 - 1. Scheduled in advance and notify the Owner's Representative at least seven (7) calendar days prior to commencing work in ceiling or interstitial spaces above Protection Areas to allow the Owner to relocate or protect occupants.
 - 2. Inform the Owner's Representative so that doors to Protection spaces near ceiling work can be kept closed while Work is in progress.
 - 3. Cover all horizontal surfaces, except flooring, to protect from dust and debris.
 - 4. HEPA/ULPA vacuum the top of the ceiling system to be removed, and surrounding affected area, to remove dust prior to removal.
 - 5. Acoustical ceiling panels or ceiling access panels opened for investigation outside of the containment areas shall be closed when unattended.
 - 6. Whenever acoustical ceiling panels or access panels are opened in Protection Areas, provide a portable enclosure that encloses the ladder and seals off opening. Fit enclosure tight to ceiling.
 - 7. Exercise caution when handling fluids within ceiling or interstitial spaces.
 - 8. When working with fluids provide a watertight barrier beneath the work area to catch and retain all spillage before it reaches the ceiling below.
 - 9. Vacuum and clean surfaces free of dust before their removal.

E. Cleaning Class III Areas:

1. Clean up and disposal
 - a. Barriers may not be removed from work areas until the completed project is inspected by the Owner's Representative and thoroughly cleaned by the Contractor.
 - b. Remove all debris, extra materials and equipment from the Containment Area before beginning final cleaning.
 - c. Work areas shall be vacuumed with HEPA/ULPA filtered vacuums and/or wet mopped by the Contractor.
 - d. When construction is complete, the temporary partitions (both sides) shall be wiped down using a moist cloth or dust catching device before removal. The partitions shall be removed carefully, rolling the inside over the outside.
 - e. Clean the blockage of air vents, diffusers and registers before their removal. Then remove them.

3.06 WORK ENCLOSURE OUTSIDE OF THE PRIMARY CONTAINMENT AREA
(SECONDARY CONTAINMENT)

A. Whenever work is necessary outside of a containment area:

1. Work shall be scheduled in advance with the Owner's Representative.
2. Contain work within a full height portable enclosure. Contractor may use prefabricated enclosure unit.
3. Seal opening upon entering or leaving enclosure.
4. At no time shall construction equipment or material be stored outside of the enclosure.
5. Dust tracked outside of construction area shall be cleaned up immediately.
6. The Contractor shall have necessary manpower and equipment (HEPA/ULPA filtered vacuum, dust and wet mops, brooms, buckets and clean wiping rags) to keep adjacent occupied areas clean at all times.

3.07 WORK CONFINED TO INDIVIDUAL ROOMS

A. Work activities which are required within a protection area which can be confined to individual rooms may be permitted as follows:

1. Scheduled in advance and notify the Owner's Representative at least seven (7) calendar days prior to commencing work in the room to allow the Owner to relocate or protect occupants.
2. The room shall be treated as a containment area.
3. Keep the door to such areas closed and sealed while work is being performed.
4. Cap HVAC ductwork or seal air supply diffusers and return grills.
5. Provide negative pressure in the room by use of negative air machine.
6. Traffic between the room and adjacent areas shall be kept to a minimum.
7. Transport materials and waste into and from the room through adjacent areas by transporting in tightly covered and sealed containers or carts.
8. At no time shall construction equipment or material be stored outside the room.
9. All dust tracked outside of the room shall be cleaned up immediately.
10. Vacuum and clean surfaces free of dust after completion of the Work.

11. Have necessary manpower and equipment (HEPA/ULPA filtered vacuum, walk off mats, dust and wet mops, buckets and clean wiping rags) to keep adjacent areas clean at all times.

END OF SECTION 01 35 33

SECTION 01 5000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
 - 2. Section 011200 "Multiple Contract Summary" for responsibilities for temporary facilities and controls for projects utilizing multiple contracts.
 - 3. Section 31 2319 "Dewatering" for disposal of ground water at Project site.
 - 4. Section 32 1216 "Asphalt Paving" for construction and maintenance of asphalt pavement for temporary roads and paved areas.
 - 5. Section 32 1313 "Concrete Paving" for construction and maintenance of cement concrete pavement for temporary roads and paved areas.

1.03 Definitions

- A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and openings are closed and fully protected.

1.04 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 engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Engineer, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: The Contractor shall coordinate access to sewer service required for Contractor's construction. The Contractor will be responsible for his sewer-service use charges for sewer used for construction operations, inclusive of any required fees and installation costs.
- C. Water Service: The Contractor shall coordinate access to water service required for Contractor's construction. The Contractor will be responsible for his water-service use charges for water used for construction operations, inclusive of any required fees and installation costs.

- D. Electric Power Service: The Contractor shall coordinate access to electricity service required for Contractor's construction. The Contractor shall be responsible for his own electrical costs, inclusive of any required meter or sub-meter fees and installation costs.

1.05 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- D. Project Identification and Temporary Signs: Show fabrication and installation details for project identification and temporary signs, including plans, elevations, details, layouts, typestyles, graphic elements, message content, and lighting.
- E. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- F. 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. 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.
- G. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
- H. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

1.06 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- D. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including, but not limited to, the following:
 - 1. Building Code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department and Rescue Squad rules.
- E. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.

1.07 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 Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.01 MATERIALS

- A. 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 galvanized-steel bases for supporting posts.
 - 1. Provide with Navy Blue privacy windscreen cover for full height of fence. Screen shall be provided with a minimum of 85 privacy blockage. Material shall be knitted high density polyethylene (HDPE). Attach to fence using UV resistant outdoor attachment fasteners.
- B. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
- C. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches .
- D. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.02 TEMPORARY FACILITIES

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

- B. Common-Use Field Office: Include office space which can be utilized by the architect, owner's rep or design team consultant. This space should be co-located with other contractor offices. Locate in close proximity to Contractor for coordination purposes. Keep office clean and orderly. Furnish and equip offices as follows
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
- C. 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.

2.03 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: 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.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV rating equal to what will be used in the completed project at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".
- C. 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

3.01 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities 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 Owner's property.

3.02 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- 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.

3.03 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- 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.
- 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.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- 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 according to coordination drawings.
 - 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 electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service overhead unless otherwise indicated or required by the local utility company.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.
- J. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install telephone line(s) for each field office.
 - 1. Provide additional telephone lines for the following:
 - a. Provide a dedicated telephone line for each facsimile machine in each field office.
 - b. Provide telephone line(s) for Owner's use.
 - 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.
 - 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- K. Electronic Communication Service: Maintain WIFI connections, and computer and printing devices in the field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications.

3.04 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 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 Owner.

- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.
 - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 312000 "Earth Moving."
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
- 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: Provide temporary parking areas for construction personnel.
- 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 Provide Project identification signs in minimum 48 inches (1.2 m) high by 96 inches (2.4 m) wide, unless otherwise indicated. Install signs adjacent to entrance to Project site and at locations required to provide project information to the public and to persons seeking access to Site. Signs shall be acceptable to Architect and Owner. Unauthorized signs are not permitted.
 - 1. Support signs with a minimum of two 4-by-4 (100 by 100 mm) by 16'-0" (4.8 m) treated wood posts embedded a minimum of 36 inches (900 mm) into ground. Provide 3/4 inch (19 mm) thick exterior grade MDO plywood sign faces with 2-by-4-inch (50-by-100-mm) treated wood framing spaced a maximum at 24 inches (600 mm) on center.
 - 2. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
 - 3. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 4. 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.
 - 5. Maintain and touch up signs so they are legible at all times.

- H. Waste Disposal Facilities: The Contractor shall provide Site waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements specified in Section 01 7419 "Construction Waste Management and Disposal."
 - 1. Contractor shall police its own work and office areas and comply with requirements of authorities having jurisdiction and the requirements specified in Section 017419 "Construction Waste Management and Disposal." Comply with progress cleaning requirements in Section 017300 "Execution."
- I. Crane, Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
 - 2. Use of cranes and other heavy lifting equipment shall be coordinated with the Owner.
- J. Temporary Elevator Use: Use of at least one new passenger elevator, and service elevator in each building during finish work will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
 - 1. Do not load elevators beyond their rated weight capacity.
 - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- K. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
 - 1. Do not load elevators beyond their rated weight capacity.
 - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- L. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. 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.
- M. 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.

3.05 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.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. 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 1000 "Summary."
- C. 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 to comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- F. 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.
- G. Site Enclosure Fence: Before construction operations begin , furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations and As indicated on Drawings, whichever is the most stringent in terms of protection.
 - 2. All construction equipment, scaffolding, hoists, etc. shall be located within enclosed fenced areas at all times. All construction equipment, scaffolding, hoists, etc. shall be located within enclosed fenced areas at all times.
 - 3. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.

4. All existing fences that are to be relocated during construction shall have either (a) the new permanent fencing installed prior to removing the existing fencing or (b) temporary fencing placed prior to removal of the existing fence. Where temporary fencing has been placed, the permanent fencing must be constructed prior to the removal of the temporary fence.
 5. Do not locate fences under drip line of trees – these areas shall be off-limits to construction activities (including storage of materials) and shall not be within fenced area.
 6. Maintain fences and barriers during the entire construction period. Relocate as required as construction progresses
 7. Provide gates as required to allow construction vehicle access to site.
 8. Removal: Remove and/or relocate fencing when work is complete in an area. Keep the site open for public use insofar as possible.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Covered 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 and requirements indicated on Drawings.
1. Construct covered walkways using scaffold or shoring framing.
 2. Provide overhead 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.
- L. 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.
- M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air-handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.
- N. 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. Prohibit smoking in construction areas.
- O. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
- P. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
1. 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.

3.06 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 - 2. Use permanent HVAC system to control humidity.
 - 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that can not be completely restored to their manufactured moisture level within 48 hours.

3.07 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 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. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
- D. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- E. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

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SECTION 01 6000 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 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.

1.02 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 012300 "Alternates" for products selected under an alternate.
 - 2. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 3. Section 014200 "References" for applicable industry standards for products specified.

1.03 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 by Engineer 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 single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the

specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.04 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
 - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.05 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.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.06 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 products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 3. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 4. Protect stored products from damage and liquids from freezing.

1.07 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- 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. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged 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. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," 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.
 - a. Submit additional documentation required by Engineer in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Engineer, whose determination is final.
- B. Product Selection Procedures:
 - 1. Sole 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.
 - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
 - 2. Sole 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.
 - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
 - 3. Limited List of Products: 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 unless otherwise indicated.
 - a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."
 - 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
 - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
 - 5. Limited List of Manufacturers: 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 unless otherwise indicated.

- a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."
7. 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. 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.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Engineer's sample," provide a product that complies with requirements and matches Engineer's sample. 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 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.02 COMPARABLE PRODUCTS

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

- B. Submittal Requirements: Approval by the Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 EXECUTION (NOT USED)

END OF SECTION 016000

SECTION 01 7300 - EXECUTION

PART 1 GENERAL

1.01 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.

1.02 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 Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.
 - 3. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.03 DEFINITIONS

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

1.04 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site .
 - 1. Prior to submitting cutting and patching plan , review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
 - a. Contractor's superintendent.
 - b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.

- d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.05 INFORMATIONAL SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- B. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. 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.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.06 QUALITY ASSURANCE

- A. 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 Engineer of locations and details of cutting and await directions from 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 the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Plumbing piping systems.
 - f. Mechanical systems piping and ducts.
 - g. Control systems.
 - h. Communication systems.
 - i. Fire-detection and -alarm systems.

- j. Conveying systems.
 - k. Electrical wiring systems.
 - l. 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.
 - h. .
 - 4. Visual Elements: Do not cut and patch construction 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 Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 PRODUCTS

2.01 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 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 Engineer for the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.01 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.

1. 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.
 2. 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 where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
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.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- 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 Engineer according to requirements in Section 013100 "Project Management and Coordination."

3.03 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish limits on use of Project site.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every major element as the Work progresses.
 - 5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
 - 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and 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 Engineer.

3.04 FIELD ENGINEERING

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

3.05 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.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. 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 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 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.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
 1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.06 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. 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.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. 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.
- E. 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 011000 "Summary."
- F. 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.
- G. 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 : 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.
 - 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.
- H. 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 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 minimize 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.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.07 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 days during normal weather or three 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.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: 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 015000 "Temporary Facilities and Controls."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to 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.

3.08 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.09 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. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

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SECTION 01 7419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.03 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 ACTION SUBMITTALS

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 024119 "Selective Demolition" for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area on-site designated by Owner.
 - 5. Protect items from damage during transport and storage.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.
- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.02 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.

3.03 ATTACHMENTS

END OF SECTION 017419

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SECTION 01 7700 - CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
 - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at final completion.

1.04 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.05 MAINTENANCE MATERIAL SUBMITTALS

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

1.06 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.
 - 5. Submit testing, adjusting, and balancing records.
 - 6. Submit sustainable design submittals not previously submitted.
 - 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 6. Advise Owner of changeover in utility services.
 - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.07 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. 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. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.08 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 .
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:

- a. Project name.
- b. Date.
- c. Name of Engineer.
- d. Name of Contractor.
- e. Page number.
4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Engineer will return annotated file.
 - b. PDF electronic file. Engineer will return annotated file.
 - c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).
 - d. Three paper copies. Engineer will return two copies.

1.09 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit by uploading to web-based project software site .
- E. Warranties in Paper Form:
 1. 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.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.01 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.

PART 3 EXECUTION

3.01 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 before requesting inspection for certification of Substantial Completion 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 not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - 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. 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.
 - k. Remove labels that are not permanent.

- l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - p. Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.
 - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - r. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."

3.02 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.

END OF SECTION 017700

SECTION 01 7823 - OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.03 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.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Engineer and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.
 - 2. Submit three paper copies. Engineer will return two copies.

- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Engineer and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer and Commissioning Authority will return copy with comments.
 - 1. Correct or revise each manual to comply with Engineer's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's and Commissioning Authority's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.05 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. 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.
 - 2. File Names and Bookmarks: Bookmark 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.

1.06 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Engineer.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.

10. Cross-reference to related systems in other operation and maintenance manuals.
 - C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
 - D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 - 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."
- 1.07 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL
- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. 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.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- 1.08 EMERGENCY MANUALS
- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
 - B. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
 - C. 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. System, subsystem, or equipment failure.
 - D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
 - E. Emergency Procedures: Include the following, as applicable:
 1. Instructions on stopping.

1.09 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

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

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. 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 warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; 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.
 - 2. 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.
 - 3. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 4. Identification and nomenclature of parts and components.
 - 5. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. 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.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. 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.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. 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.
- E. 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.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 017823

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SECTION 01 7839 - PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 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.

1.02 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. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for coordinating project record documents covering the Work of multiple contracts.
 - 2. Section 017300 "Execution" for final property survey.
 - 3. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 4. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one of file prints.
 - 3) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and three set(s) of prints.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 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.

- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

1.04 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 photographic documentation.
 - 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.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Work Change Directive.
 - k. Changes made following Engineer's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 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 important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 - 1. Format: Annotated PDF electronic file with comment function enabled.

2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Engineer for resolution.
 4. Engineer will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Engineer's digital data files.
 - b. Engineer will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.

1.05 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 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. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 5. Note related Change Orders , record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file.

1.06 RECORD PRODUCT DATA

- 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.

- B. 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.
- C. Format: Submit record Product Data as annotated PDF electronic file.
 - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.07 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.
- B. Format: Submit miscellaneous record submittals as PDF electronic file .
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.08 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

PART 2 PRODUCTS

PART 3 EXECUTION

END OF SECTION 017839

SECTION 01 7900 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
- B. Allowances: Furnish demonstration and training instruction time under the demonstration and training allowance as specified in Section 012100 "Allowances."
- C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.03 INFORMATIONAL SUBMITTALS

- A. Attendance Record: For each training module, submit list of participants and length of instruction time.
- B. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.04 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Date of video recording.
 - 2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.

3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
4. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc or usb jump drive

1.05 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

1.06 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.

1.07 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: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following 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. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
- 3. 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.
- 4. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 5. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 6. 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.
- 7. 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.

1.08 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.09 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- D. 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.
- 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 017900

SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. SCOPE

1. Commissioning requirements common to all Sections
2. Systems and equipment functional performance testing
3. Validation of proper and thorough installation of systems and equipment
4. Equipment performance verification
5. Documentation of tests, procedures, and observations
6. Review of Owner Training agenda
7. Building automation system requirements for post occupancy data collection and remote monitoring systems

B. GENERAL DESCRIPTION

1. Commissioning is the process of verifying and validating that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective to operate and meet the Owner's operational needs; that the installation is adequately documented; and that Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.
2. Commissioning Authority shall work with the Contractor and the Design Engineer to direct and oversee the Commissioning process and perform Functional Performance Testing.
3. The Commissioning Plan outlines the commissioning process.
4. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
5. This Section and other Sections of the specifications detail the Contractor's responsibilities relative to the Commissioning process. It expands on the Commissioning Plan, which covers the roles and responsibilities of all Parties. It also indicates the details of the Functional Performance Testing in which the Contractor must participate.

C. COMMISSIONING SEQUENCE AND SCHEDULE

1. Where applicable, in order to expedite the close out of the facility, various systems can be in various stages of the commissioning process. CxA and Contractor shall cooperate to schedule the Commissioning tasks to minimize the duration of Commissioning activities.
2. Commissioning will be categorized into Phases as indicated below. Note that per schedule, different systems and/or areas may be in different phases at any given time given that the Commissioning and testing process will be integrated into the construction process:
 - a. Construction Phase: This is the period of time where the systems are installed, much of the commissioning documentation is developed, the systems are started, and the majority of the contractor required training is performed. On any given

system or area, the Construction Phase will end when the CxA determines that the prerequisite start-up requirements have been met and the system is ready for FPT (Functional Performance Testing). This period shall also be used to flush-out the systems and allow the CxA to evaluate BAS trending to optimize system performance.

- 1) Pre-Start Up checklists completed by the installing contractor.
 - 2) Start-up checklists, tests and OEM procedures completed by the installing contractor.
 - 3) HVAC TAB completed and final report is available for review prior to beginning FPT.
- b. Acceptance Phase: This is the period of time where the systems will be functionally tested and will operate through a Transition period.
- 1) Equipment and Systems functional performance testing
 - 2) Integrated systems functional performance testing
 - 3) Trend data setup and archiving verification for remote monitoring systems
- c. Warranty Phase: Includes the early occupancy of the building and can continue through the Warranty Period and at least into the opposite season from when it was initially tested.
- 1) Deferred Functional Testing: FPTs that are performed later during the warranty phase, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.
 - 2) Continued coordination of integration of trend data into remote monitoring systems
- d. Commissioning Kick Off and Coordination Meetings
- 1) CxA shall schedule and conduct a Commissioning Kick Off meeting near the beginning of construction. The following should be discussed at this meeting:
 - a) CxA will present
 - 1 The Commissioning Documents
 - 2 Requirements of Commissioning
 - 3 Responsibilities of the construction parties
 - 4 Management protocols
 - 5 Required submittals
 - 6 Schedule
 - b) Cx coordination meetings will be organized and led by the CxA as required to ensure the successful completion of the project.
- e. Phasing Plan
- 1) If contractor intends to start, run, or occupy portions of systems in phases, contractor shall submit a plan for phasing in areas/portions of systems that will be connected subsequent to the initial portions. Specifically address:
 - a) Pipe and Duct Cleaning: Indicate the configurations and protocols for isolating subsequent regions and then protecting the preceding regions when the subsequent region is cleaned, flushed and connected.
 - b) Pipe disinfection: Indicate the plan for disinfecting each region of potable water that requires disinfection. Indicate how the preceding

regions of the system will be protected when connecting subsequent regions.

- c) System Modifications: Indicate the protocols for making subsequent changes to the systems of pipe and duct when the systems have already been cleaned, flushed, pressure tested, disinfected, certified, etc.
- d) HVAC Equipment: Indicate the protocols for operating the HVAC equipment in a construction environment. The plan shall, at a minimum, include; filtering, operation, maintenance, and Control System responsibilities.

1.02 ADMINISTRATIVE REQUIREMENTS

A. RELATED WORK AND DOCUMENTS

1. Commissioning Plan: The Commissioning Plan is a part of the Contract Documents and outlines many of responsibilities, procedures and tasks throughout the Commissioning process. It also describes the Functional Performance Tests that will be performed during the Acceptance Phase. The Contractor must have an understanding of commissioning process and the Contractor requirements within the plan.
2. Individual Specification Sections (Divisions): Individual sections stipulate installation, start-up, warranty, operation and maintenance documentation, and training requirements for the system or device specified in the Section.
 - a. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)
 - b. Division 26 - Electrical
3. Reference Standards
 - a. ASHRAE Guideline 202-2013, "The Commissioning Process"
 - b. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"
 - c. ASHRAE Guideline 4-1993, "Preparation of Operating and Maintenance Documentation for Building Systems"
 - d. BCA - Building Commissioning Association
 - e. NEBB - Procedural Standards for Building Systems Commissioning
 - f. NETA-ATS, Testing Standards
 - g. National Electric Code (NEC)
 - h. American Society for Testing and Materials (ASTM)
 - i. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)
 - j. Illuminating Engineering Society (IES)
 - k. Institute of Electrical and Electronics Engineers (IEEE)
 - l. International Electrical Testing Association (NETA)
 - m. National Electrical Manufacturers Associates (NEMA)
 - n. National Fire Protection Association (NFPA)
 - o. Underwriters Laboratory, Inc. (UL)

B. DEFINITIONS AND ABBREVIATIONS

1. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and formal training occurs. This will generally occur after the Construction Phase is complete (start-up and checks have been accomplished).

The Acceptance Phase typically begins with Substantial Completion and ends with Functional Completion.

2. Observation Log: This is a list that is maintained that includes all Observation Items that relate to Commissioning activities and site observations requiring contractor action or response.
3. Building Automation System (BAS): The computer-based heating, ventilation and air-conditioning (HVAC) control or automation system
4. Commissioning Authority (CA or CxA): The Party retained by the Owner who will oversee the Commissioning process as well as develop and stipulate many of the Commissioning requirements. They will also manage the Commissioning process, and ensure and validate that systems and equipment are designed, installed and tested to meet the Owner's requirements.
5. Commissioning Coordinator (CxC): This refers to the Individual within each of the various Parties that is designated the point of contact for that Party relative to Commissioning activities.
6. Commissioning Portal: This is an internet hub for the collaboration on Commissioning information. This portal will act as a hub for posting electronic information.
7. Commissioning Team (CxT): The group of Parties involved in the commissioning process for any given system. The Commissioning Team will include a core group involved with all systems. This core group will typically include the CxA, [the Construction Manager's Commissioning Coordinator (CM-CxC)], [the Owner's Commissioning Coordinator (O/O-CxC)] and the General Contractor's Commissioning Coordinator (GC-CxC). On any given system, the Commissioning Team will also include the Commissioning Coordinator for the Contractor(s) responsible for the system or equipment.
8. Contractor: As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the General Contractor, subcontractors, or vendors as inferred by its usage.
9. Construction Manager (CM): The Party retained by the Owner to represent the Owner and make decisions on the Owner's behalf throughout the design and construction process.
10. Construction Phase: Phase of the project during which the facility is constructed and/or systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete start-up documentation, submit operation and maintenance information, establish trends, and perform any other applicable requirements to get systems started. Contractor and Vendors may also conduct equipment specific training. The Construction Phase will generally end upon completed start-up and test, adjust and balance of systems and equipment.
11. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent).
12. Engineer of Record - Design Team Engineer lead-design entity
13. Factory Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
14. Factory Testing: Testing of equipment off-site at the manufacturer's facility. The testing may be witnessed by the members of the project team.
15. Functional Performance Testing (FPT): The detailed and thorough testing of building systems and their interactions with building components and other building systems.
16. IAQ: Indoor Air Quality

17. Operation and Maintenance (O&M) Documentation: This refers to Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. The foundation of O&M Documentation is manufacturer's literature (including 'O&M Manuals', parts lists, troubleshooting guides, etc.) as well as Contractor-developed instructions for start-up and shut-down, sequences, and other installation-specific information. O&M Documentation content is a subset of the Facility Manual, so it is common for only one or the other to be specified. All documentation shall be submitted to Owner in electronic format.
18. Transition Period: Time period after FPT completed to operate systems to purge the building and stabilize equipment operations. Time is also used by the CxA to test system performance.
19. Opposite Season: The season opposite that when the majority of the testing occurs.
20. Pre-Start Up: Preliminary testing accomplished during a scheduled system outage to verify system functionality prior to placing the system/equipment into preliminary service.
21. Start-Up: Refers to the quality control process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the Start-Up Checklist, energizes the device, verifies that it is in proper working order and ready for dynamic testing, including Start-Up Tests.
22. TAB: Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor.
23. Trending: Monitoring and recording a history of parameters typically using the BAS.
24. Warranty Phase: Includes the early occupancy of the building and can continue through the Warranty Period and at least into the opposite season from when it was initially tested.

C. COORDINATION MANAGEMENT PROTOCOL

1. Coordination responsibilities and management protocols relative to Commissioning are initially defined below but will be refined and documented in the Commissioning Plan. Contractor shall have input in the protocols and all parties will commit to scheduled obligations. The CxA will record and distribute.
 - a. Submittals and Shop Drawings: CM shall distribute the submittal log to the CxA. CxA shall review the submittal log and communicate which submittals need to be forwarded.
 - b. CxA Review Comments for Shop Drawings: An email reply is sent directly to the CM, Engineer of Record, and Owner by the CxA. The Owner and Engineer of Record will consider and incorporate at their discretion.
 - c. Deficiencies Identified by the Commissioning Authority: When the CxA identifies a deficiency the CxA shall make a good faith assessment of responsible parties. Those parties, as well as the Owner and CM shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a direction to resolve the deficiency or to take any action. Contractor may elect to accept responsibility and resolve the deficiency. If the contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Commissioning dialogue, CM shall issue a work directive or RFI via the normal contractual channels to resolve the issue.
 - d. Requests for Meetings: In general, request by the contractor for a meeting with the CxA shall be routed through Owner and CM who will then determine the validity.

Note that every attempt should be made to deal with Commissioning issues at regularly scheduled Commissioning Meetings.

- e. Control Sequence Modifications: CxA shall review the sequences during the design and submittal phases and address any known concerns prior to the submittal approval. Any recommendations for control sequence modification must be presented to the Owner and Engineer of Record for approval. Any and all changes approved by the Owner and Engineer of Record must be thoroughly documented in the record documents.
 - f. Notification of Completion Milestones: Contractor shall notify the CxA, Owner and CM at least one week prior to any anticipated Commissioning activity or Commissioning milestone (such as FPT). The Owner or CM (as applicable) shall then coordinate the scheduling of the activity between all required parties. Notification shall be via email.
 - g. Observation Log: The observation log is maintained electronically which tracks the Commissioning related action items. The log is accessible at all times to the Cx team members.
 - h. Start-Up Checklist and Test Documents: Installing contractors will provide an electronic copy of in-house start-up checklists and test documents to the Owner, CxA, and CM for review, comment and acceptance. The Contractor then performs the reviewed and approved Start-Up procedures, completes the documentation and signs, and submits it. CxA subsequently spot checks the procedures and documentation during the FPT. They are then included in the Commissioning Record.
 - i. Functional Performance Test Documents: FPTs are witnessed and documented by the CxA but performed by the contractor. They are developed during the construction phase generally after completed submittals. CxA drafts and forwards the FPT procedures to the CM to be subsequently distributed to the subcontractors for review by the CM. Contractors review and comment on the procedures. Throughout the Commissioning process, CxA maintains a current record of the testing procedures and keeps the documentation up to date and accessible for all to access the current progress. CxA normally distributes hard copies of the testing procedures at completion of any significant stage of Commissioning.
2. Coordination Between Testing Parties
- a. Factory Start-Ups: For many systems and equipment, Factory Start-Ups are specified. These Factory Start-Ups will be reviewed and checked during FPT. All costs associated with the Factory Start-Ups are included with the bid unless otherwise noted. Contractor shall make notification of when Factory Start-Ups are occurring and coordinate these with witnessing Parties. The CxA and CxT members may witness Factory Start-Ups at their discretion. Aspects of FPT accomplished during the Factory Start-Ups may be accomplished and approved by the CxA if they meet the intent of the FPT.
 - b. Independent Testing Agencies: For systems where contractor's independent testing agencies are specified, the cost of this testing is included with the bid unless otherwise noted. Much of the testing performed by these independent agencies will cover aspects required in the Start-Up Procedures and FPTs.
 - c. Contractor and testing agencies shall coordinate with the CxA so that the CxA can witness the testing and approve the applicable aspects of the FPTs. The Contractor should not start up equipment or systems without CxA approval.

- d. The CxA may independently spot-check work of the testing agencies if the tests were not witnessed. However, it is not the intent for the CxA to re-accomplish testing by others that is specified in the construction specifications.
- e. Contractor is responsible for coordinating the efforts of testing agency with that of the Cx process. Documentation shall be contiguous and seamless and duplication will be avoided. Testing agencies shall complete the documentation of the Cx process as required.

D. CONTRACTOR RESPONSIBILITIES

- 1. Construction Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Construction Phase.
 - a. Include Commissioning requirements in price and plan for work.
 - b. Designate a CxC from each major subcontractor with activities related to commissioning. These CxCs are to be the primary contacts for Commissioning activities.
 - c. Attend Construction Phase Commissioning Kick Off Meeting. The CxC and Project Manager from each major subcontractor shall attend at a minimum.
 - d. The CxC shall attend all Commissioning progress meetings unless otherwise agreed to by the CxA.
 - e. Remedy any deficiencies identified throughout construction.
 - f. Submit Start-Up Procedures along with the manufacturer's application, installation and start-up information to the CxA for review prior to implementation.
 - g. TAB shall submit sample balancing forms and TAB Plan for review and approval prior to starting work.
 - h. Contractor shall incorporate the Commissioning process into the construction schedule outlining generic Commissioning tasks with precedents or prerequisites to each task. These tasks will apply to many systems and the Contractor shall incorporate as such. Examples of enumerated tasks include:
 - 1) Contractor preparation of the Training Plan
 - 2) Testing Agency activities
 - 3) Contractor documentation of pipe pressure testing, flushing, and cleaning of applicable systems
 - 4) Documentation of the Start-Up Procedures for equipment and systems
 - 5) TAB of applicable system
 - 6) Training Events
 - 7) Preparation of the O&M Manual content
 - 8) FPT and Acceptance
 - 9) Observation Period and System Optimization
 - 10) Occupant or other Regulatory Agency testing or approval process
 - i. Coordinate the work of subcontractors, vendors, manufacturers, and Testing Agencies provided with the bid, and ensure that they are informed of and are adhering to the requirements of the Commissioning process specified throughout the contract documents. Particular reference is made to providing the required O&M Documentation; submittal of training materials and documentation of that training; collaboration with the overall start-up and testing process; developing comprehensive integrated procedures for scheduling and task notification and documenting them in a common format; and electronic delivery requirements if applicable.

- j. Provide assistance to the CxA in preparation for the specific FPT procedures. Contractors, subcontractors and vendors shall review the FPTs to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures that is the result of malfunctioning equipment or contract deficiencies, shall be the responsibility of the Contractor.
 - k. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this section. The Contractor (and subcontractors) shall record, in the form of photographs, compliance to and/or deviation from IAQ standards.
 - l. Contractor shall notify the CxA at least 7 days in advance of any tests, start-ups, or training. CxA shall witness selected tests and start-ups. Notification shall be accompanied by a schedule showing the coordinated start date and task duration and all open prerequisites
 - m. Start-up, TAB of systems and equipment prior to verification and FPT by the CxA. Start-up procedures shall be in accordance with Contract Documents, reference or industry standards, and Commissioning specs. Provide skilled technicians who are qualified to do the work required. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Generally start-up and testing shall proceed from device checkout, to component checkout, to system checkout, to inter-system checkout.
 - n. Record start-up and testing procedures on start-up forms or checklists and certify that the systems and equipment have been started and/or tested in accordance with the requirements specified above. Each task or item shall be indicated with the party actually performing the task or procedure.
 - o. Demonstrate the operation of all systems as specified.
 - p. Certify that systems have been installed and are operating per Contract Documents and OEM prior to FPT and acceptance.
 - q. Maintain an updated set of Record Documentation as required by the Contract Documents.
 - r. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to each piece of equipment or system and general training requirements.
 - s. Operate systems under direction of the CxA during FPT's and other acceptance testing.
 - t. Coordinate trend point naming convention with CxA to ensure that systems are properly setup for data storage and remote monitoring capabilities.
2. Acceptance Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.
- a. Will work in conjunction with CxA in FPT and will generally include the following:
 - 1) Operate and Manipulate systems and equipment to facilitate testing (as dictated in this section, relevant technical sections and the Commissioning Plan).
 - 2) Operate and Manipulate BAS and other control systems to facilitate FPT (as dictated in this section, relevant technical sections and the Commissioning Plan).
 - b. Correct any work not in accordance with Contract Documents.

- c. Maintain record documentation and update and resubmit it after Functional Completion.
 - d. Compensate the Owner for additional CxA fees and expenses incurred to retest equipment and systems following testing failures.
 - e. Monitor systems, equipment and areas throughout the Transition Period. Log and diagnose all alarms during this period. Maintain trends and logs of all critical parameters. Forward the logs and trends on a weekly basis throughout all Transition Periods.
 - f. Setup trends for archiving as required by CxA for specified data collection and remote monitoring capabilities.
- 3. Warranty Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Warranty Phase.
 - a. Provide warranty service
 - b. Conduct BAS Sequence Training
 - c. Respond to and document Warranty issues
 - d. Participate as required in the opposite season testing
 - e. Correct any deficiencies identified throughout the Warranty Phase
 - f. Update record documentation to reflect any changes made throughout the Warranty Phase and resubmit final Record Drawings and data records at the close of the Warranty period.
 - g. Assist CxA with any additional point naming or trend archiving requests to assist with on-going remote monitoring.

E. OBSERVATION LOG

- 1. CxA shall maintain an Observation Log (required information, identified deficiencies, work required, etc.) that relates to Commissioning. Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.
- 2. CxA will disseminate this list as appropriate to keep all parties informed.
- 3. All parties indicated as responsible for an action item shall respond. The preferred response method is via e-mail. Response with a plan of action (either repair or plan to resolve) is expected within 48 hours.

1.03 SUBMITTAL

- A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.
- B. The Commissioning authority will review and provide comment on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the

commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the CM, Owner Representative, or Engineer of Record as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

- C. The CxA may request additional design narrative from the Engineer of Record and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and approve them.
- E. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.

PART 2 PRODUCTS

2.01 INSTRUMENTATION

- A. All test instruments described in this section shall be acceptable for any portion of the commissioning process herein described. All instruments shall conform to the standards specified in the most recent edition of "NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" in regard to accuracy and calibration status. Current calibration certificates must be available to the CxA if requested.
- B. Test instrument accuracy and resolution must match or exceed that of the system component being verified or calibrated.
- C. Test instruments must be used within guidelines as recommended by instrument manufacturer. All measuring methods must be appropriate to the instrument application and measurements must be repeatable under equivalent conditions.
- D. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis will be provided by Cx Authority. These include:
 - 1. Electronic Manometer (for Air and Flow Hood)
 - 2. Electronic Manometer (for Water)
 - 3. Temperature Instruments
 - 4. Humidity Instruments
 - 5. CO2 Instrument
 - 6. Sound Meter
 - 7. Electronic Multimeter
 - 8. Tachometer
 - 9. Ultrasonic Flow Meter
 - 10. Others as required

PART 3 EXECUTION

3.01 PRE-START UP

A. PREREQUISITES

1. All equipment, components, and devices applicable to the Pre-Start Up must be installed, and the Pre-Start Up must be documented and approved. This includes installation, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.

B. COMMON ELEMENTS

1. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.
2. Contractor shall provide the completed Pre-Start Up Procedures at the time of testing. CxA shall review the Pre-Start Up Procedure documentation and spot-check at the beginning of Start Up.
3. Contractor shall demonstrate that access is sufficient to perform required maintenance.
4. System and equipment configurations shall be compared against the contract documents.

3.02 START-UP

A. PREREQUISITES

1. All equipment, components, and devices applicable to the FPT must be started, and the Start-Up must be documented and approved. This includes completion of Start-Up Procedures, pressure testing (of equipment, duct and piping), flushing/cleaning, identification labeling, insulation, and all other requirements for placing systems into dynamic operation.
2. Unless specifically agreed to by the Owner and CxA, all support systems shall be complete prior to FPT. For instance, an air handler will require that:
 - a. The electrical system serving it is completed and tested.
 - b. The hydronic systems serving it have been pressure tested, flushed, and functional performance tested.
 - c. Balancing has been completed.
 - d. The control systems have been started and calibrated.
 - e. The CxA shall determine the optimal sequence of testing.

B. COMMON ELEMENTS

1. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.
2. Contractor shall provide the completed Start-Up Procedures at the time of testing. CxA shall review the Start-Up Procedure documentation and spot-check at the beginning of FPT.
3. Contractor shall demonstrate that access is sufficient to perform required maintenance.
4. BAS trends shall have been established as required in the documents. These shall generally be reviewed prior to or during FPT.
5. Capacities and adjusted/balanced conditions as applicable shall be subject to review.

6. Sequencing Verification: For applicable systems and equipment, all modes of operation shall be verified for proper sequencing.
7. System and equipment configurations shall be compared against the contract documents.
8. Verify Modes (such as heating and cooling) are coordinated and do not overlap or 'fight'.
9. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation.
10. BAS or Local Panel Dynamic Graphics: The graphic displays for all components, systems, and areas required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints or other parameters are required to be adjustable, CxA shall verify that they can be adjusted directly from the graphic screen.

C. START-UP PROCEDURE

1. Purpose: The Commissioning process requires that the normal quality control processes involved with preparing systems and equipment for operation are performed to a high standard of care and are thoroughly documented. The required commissioning-related Start-Up Procedures involve nothing additional over that which would be done for a proper installation. These procedures shall be performed on all installed systems and equipment and no sampling strategy is used for the start-up process. The Commissioning process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-up Procedures that are developed by the Contractor.
2. Start-Up Procedures: The content of these Start-Up Procedures shall provide the minimally acceptable content in accordance with the OEM field quality control requirements. Generic refers to the fact that the protocols may be created before the shop drawings are finalized. These procedures and protocols will normally be common across different manufacturers.
3. Content of Start-Up Procedures: Start-Up Procedures shall generally include the following for each item of equipment or system (as applicable):
 - a. Project-specific designation, location and service.
 - b. Indication of the Party performing and documenting the Start-Up Procedure.
 - c. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measure parameters.
 - d. A Start-up Checklist item indicating that proper maintenance clearances have been maintained.
4. Recording and Documentation of Factory Start-Up: Manufacturer's start-up protocols shall be executed and forms shall be completed by a qualified/authorized technician.
5. Recording and Documentation of non-Factory Start-Up: The start-up tests and checklists shall be completed by a qualified technician.
6. Commissioning Authority Review: CxA will review and spot-check procedures during FPT.
7. Documentation Completion: The individual executing the start-up must complete the start-up and pre-functional documentation for any given equipment and acknowledge acceptability with the indication of who did the associated task.
8. Sampling and Final Submission: All (100% of) systems are started and documented per the approved procedures and NO sampling strategy is used. Completed Start-up and pre-functional checklists for all pieces of equipment associated with independent systems

shall be submitted to CxA prior to any associated FPT. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.

9. Owner Access: Contractor shall allow access by Owner representatives to inspect the equipment and ensure its proper operation.

3.03 TEST, ADJUST, AND BALANCE

A. TEST, ADJUST, AND BALANCE

1. CxA shall review TAB reports.
2. The CxA will select up to 10% of the readings from the Balancing Reports and spot check them, as part of the time allocations for the various systems. If subsequent failures are found, the TAB contractor will be required to justify noted failures or rebalance and re-document the system. The maximum failure rate for this sample is 10%. The readings selected by the CxA may include supply air diffuser readings (both minimum and maximum readings for variable air volume boxes), main and branch supply duct traverse readings, outside/return air flow readings, exhaust air flow readings, water flow readings, amp readings, and water pressure drop readings through coils, heat exchangers, and other hydronic elements. For all readings a deviation of more than 10% between the verification reading and reported data shall be considered as failing the FPT.

3.04 FUNCTIONAL PERFORMANCE TESTING

A. FUNCTIONAL PERFORMANCE TESTING

1. Objectives and Scope
 - a. The objective of FPT is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, thus improving the function and operation of the systems.
 - b. Each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, normal and emergency power, fire alarm, part-and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, no flow, equipment failure, etc. shall also be tested.
2. Development of Test Procedures
 - a. CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection, and scope. The CxA will also submit the tests to the Engineer of Record for review.
 - b. Contractor shall review the FPTs in detail and submit edits and comments to the CxA for possible incorporation.
 - c. The purpose of any given specific FPT is to verify and document compliance with the stated criteria of acceptance, modes of operation and performance.
3. Scheduling: After Contractors' notification that systems are ready for testing and submittal and review of all the required submittals has occurred, CM shall schedule the

testing. To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.

4. Phasing: Non-interdependent segments of the project testing can be phased. Phasing of this project will be determined as the project progresses.
5. Participation: CxA will direct, witness and document FPTs performed by the contractor after Start-Up Procedure documentation of systems and equipment has been reviewed and accepted. CxA will orchestrate the execution of the FPTs unless otherwise specified. Contractor shall perform the FPTs as described in section 3.4 with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment), and on-the-spot remediation of minor identified deficiencies whenever possible.
 - a. Required participating Parties shall be indicated in the individual FPT. Typically, multiple Parties are required for any given test, yet participation for any given Party is only required for the respective portion of the test for which the Party is responsible.
 - b. Frequently, on multiple samples where a given party does not directly perform the test, the participation of that party will only be required for an initial quantity of systems/equipment. Whenever practical and at the discretion of the CxA with the contractor's full approval, the CxA will continue with the remaining portion of the sample without assistance from the Contractor(s) not directly performing the test. However, the Contractor is allowed to be present for any or all FPTs conducted.
 - c. The required parties shall be available on-site throughout the testing of any given system for which they are required participants. Therefore, time for which they are not directly involved can be spent performing other work (typically addressing identified punch list items or failed tests).
 - d. No party involved with the project is prohibited from participation in or witnessing of any tests. Any Contractor may elect to witness all tests on their systems even if their involvement is not directly required (for instance, BAS Vendor involvement is sometimes required on the first few of a sample and not on the entire sample).
 - e. CxA will endeavor to coordinate effectively with the individual Contractors throughout FPT and minimize their required involvement.
6. Completeness: All systems must be completed and ready for FPT. All start up, factory authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and started for the respective system or component.
7. Test Documentation: CxA will witness and document the tests. CxA will record all test results on the forms developed for the testing. CxA will 'Pass' or 'Fail' the testing and record the date and time of the test. Deficiencies shall clearly be indicated when the test is failed. When all related testing is completed successfully, CxA shall recommend acceptance of the system or component. In the case of specialized testing, witness (at CxA's discretion) and review the testing reports prepared by the Contractor.

B. FPT ACCEPTANCE

1. The Acceptance Criteria shall be as follows unless specifically indicated within applicable individual specification sections or test procedures. CxA may exercise professional judgment to relax requirements and pass tests and recommend approval by the Owner and Engineer when appropriate.
 - a. Accuracy/repeatability on sensing devices will be as specified for the device. CxA and TAB will use calibrated gages for independent validation and use judgment in

passing or failing the devices. In many cases, the coordination of multiple related sensors is more important than absolute accuracy.

- b. HVAC sequence-related criteria will be as explicitly specified in the documents and as interpreted by the CxA.

C. FPT DEFICIENCIES

1. Non-Conformance: Non-conformance deficiencies identified during FPT shall be resolved as follows:
 - a. The CxA will record the results of the functional test. All deficiencies or non-conformance issues shall be noted as Observation Log Items and reported to the Owner and CM.
 - b. Corrections of identified minor deficiencies may be made during the tests at the discretion of the CxA. In such cases the deficiency will be noted on the FPT documents.
 - c. Every effort will be made by the CxA to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
 - d. As tests progress and deficiencies are identified, the CxA will discuss the issue with the executing Contractor.
 - 1) When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:
 - a) The CxA shall document the deficiency along with the Contractor's response and intentions, and they go on to another test or sequence. A copy/email of the deficiency shall be generated and provided to the Contractor and CxA. The Contractor corrects the deficiency, completes the Action Item response certifying that the issue is resolved and/or the equipment is ready to be retested, and sends it back to the CxA.
 - b) The CxA reschedules the test and the test is repeated.
 - c) The CxA has an allowance of one re-test, cost for additional re-tests greater than this allowance will be charged to the Contractor.
 - 2) If there is a dispute about a deficiency, regarding whether it is a deficiency and/or who is responsible:
 - a) The deficiency shall be documented as an Observation Log Item with the Contractor's response and the Owner and CM will be notified. The CM will track this issue under the construction contract dispute resolution provisions.
 - b) Final interpretive authority is with the Engineer of Record. Final acceptance authority is with the Owner and CM.
 - c) The CxA documents the resolution to the Observation Log Item.
 - d) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved. CxA then closes the Action Item.
2. Max Failure Limit and Sample Percentages: A Maximum Failure Limit is indicated along with the Sampling Percentages. The Max Failure Limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. This is based on the concept that if many failures occur, it is a

result of inadequate start-up by the Contractor. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

- a. If no Max Failure Limit is indicated, all tested samples must pass (Max Failure Limit 0%).
 - b. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems) the Maximum Failure Limit will apply per system.
 - c. The responsible Contractors shall reimburse the Owner for the CxA's cost of that sample test, and redo the start-up and TAB for the applicable devices/systems.
 - d. All work necessitated by sample failures shall be at no cost to the Owner.
3. Failure Due to Manufacturer's Defects: If 10% of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, all identical units may be considered unacceptable by the CM. (For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.) In case of failure due to manufacturer's defects, the Contractor shall provide the Owner with the following:
- a. Manufacturer's response in writing as to the cause of the failure and proposed resolution.
 - b. Manufacturer shall implement their proposed resolution on a representative sample of the product.
 - c. The CM will determine whether a replacement of all identical units or a repair is acceptable.
 - d. Upon acceptance, the manufacturer shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
 - e. Manufacturer shall pay the costs of all retesting necessitated by the failure.

3.05 CLOSEOUT

A. CX REPORT

1. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the CM, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Pre-Start Up verification, Start Up checklists, TAB, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

B. ACCEPTANCE

1. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the CM, if necessary. The CxA recommends acceptance of each test to the CM using a standard form. The CM gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

C. TRAINING

1. The CM shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.

2. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

3.06 OPERATION AND MAINTENANCE

A. O&M AND SYSTEM MANUAL

1. Prior to substantial completion, the CxA shall review the O&M manuals, documentation and redline as-builds for systems that were commissioned to verify compliance with the Specifications. The CxA will communicate deficiencies in the manuals to the CM or Engineer of Record, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the CM or Engineer of Record. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the ENGINEER OF RECORD's review of the O&M manuals according to the Engineer of Record's contract.

B. WARRANTY REVIEW

1. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

3.07 REQUIREMENTS FOR REMOTE MONITORING

A. Trend Log Object Naming Conventions

1. The trend log object name shall follow either a client, controls contractor, or Engineer of Record supplied naming convention.
2. If the naming convention is supplied by the controls contractor, an electronic spreadsheet copy shall be provided to the client and Engineer of Record outlining the naming convention for approval prior to implementation.
3. The trend log object name shall also include the equipment and building name for which it belongs to. Trend point names such as "Dev10001-A110" are not acceptable.

B. Trend Log Intervals

1. Binary Objects (BO & BI) - value trended as Change Of Value (COV).
2. Analog Objects (AO & AI) - value trended on 15-minute intervals.
3. Any setpoint (AV) that is dynamic (i.e.: is reset by control logic) - value trended on 15-minute intervals.
4. Any setpoint (AV) that is static (fixed value that can be overridden through BAS user interface) - value trended as COV.
5. Binary or Multi-State Mode Points (BV, MO, & MV) - value trended as COV.

C. Trend Archiving

1. BAS controllers shall be configured and have the capacity to store a minimum of three (3) days of point trend data for all objects described above for each controller. Building controllers shall be provided to support Trend Log Objects for all control objects in controllers that do not support Trend Log Objects. The network and trending

configuration shall be designed to collect required trend data without negatively affecting system performance.

2. Enterprise Server - Trend Log data shall be collected daily from BAS controllers and stored for a minimum of 12 months on the server.

D. Owner Coordination

1. Controls contractor to work with Owner and Engineer of Record to make available on-going scheduled extracts/exports from automation system trends or databases to owner remote monitoring service in a common, compatible format.

END OF SECTION

SECTION 21 0010 - FIRE SUPPRESSION GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Consult them for further instructions and be governed by the requirements thereunder.
- B. Related Work is specified elsewhere in Divisions 22, 23, 25, and 26, and when issued by the Owner, is hereby incorporated.

1.02 GENERAL

A. Work Included

1. Furnish all labor, materials, equipment and related items, and perform all operations required to complete work within the intent of the Drawings and Specifications, whether or not specifically mentioned, and to deliver complete and fully operational fire suppression systems subject to the conditions of the Contract. For this reason, the Contractor shall visit the premises and site before submitting their bid and familiarize themselves with the areas in which work is to be done.
2. Provide fire suppression piping and electrical details not mentioned or shown which are necessary for the successful operation of all systems. Clean, sterilize, flush and fill all systems per requirements to make them operational; including labor and materials for final fill of water, refrigerant, oils, grease, gases, antifreeze and brine.
3. Set all sleeves and cut and patch all miscellaneous holes necessary for the convenient, orderly and proper installation of the work. Required holes through masonry and concrete construction with an area less than thirty five (35) square inches (20 inch diameter and less) shall be considered miscellaneous holes.
4. Any work installed without regard to the work of other crafts which must, in the opinion of the Owner or Architect/Engineer, be moved to permit the installation of other work, shall be moved and replaced as a part of this work at no additional charge.
5. Rough-in for and connect, as shown on the drawings, all equipment furnished by the
6. Prove satisfactory operation of all equipment and controls to the Owner, Architect, and/or Engineer upon request.

B. Work Not Included

1. Certain labor and materials may be furnished and/or installed under other divisions of these specifications. Coordinate with other trades and arrange the work to make the parts fit together. The following items are to be accomplished under other divisions of these specifications.
 - a. Roof Curbs: See "Roof Curbs" Paragraph in this Specification Section.
 - b. Concrete: See "Concrete" Paragraph in this Specification Section.
 - c. Electrical Equipment and Wiring: See "Electrical Equipment and Wiring for Mechanical Division" Paragraph in this Specification Section.

- C. Equipment Furnished by Owner
 - 1. The Owner will award contracts, which will commence concurrently with this contract. Specifically this work will include:
 - 2. Equipment Installation: Refer to appropriate drawings for equipment furnished by the Owner.
 - 3. Rough-in service pipes to locations as required by architectural and mechanical drawings and equipment shop drawings. Provide service valves on all pipes. Final connections to equipment shall be made by Contractor.

1.03 QUALITY ASSURANCE

- A. Qualifications of Contractor: All materials and equipment shall be new and all work shall be executed with the maximum speed consistent with current accepted trade practices. Furnish materials and equipment promptly after authorization to proceed, and proceed with work in progress with the other contractors on the project. Perform all work included in the contract in a manner that will not cause interferences or delays to, or interfere with, the progress of other contractors.
- B. At all times when work is not in progress, keep all open ends of pipe, fittings, equipment and fixtures securely closed and protected.
- C. All welding shall comply with the requirements and recommendations of the American Welding Society and all applicable codes.
 - 1. Weld metal shall not project creating an obstruction.
 - 2. Chip or grind out all weld metal before re-welding.
 - 3. Caulking / preening of welds is not allowed.
 - 4. Welder shall be certified to work on service/utility type indicated.

1.04 CODES AND REFERENCED STANDARDS

- A. Comply with specified Codes and Standards. If conflict exists between Codes or Standards and drawings, project specifications manual or addenda requirements, the most stringent requirement shall apply.
- B. Conform to the installation rules and regulations of the standards listed including all subsequently published amendments thereto issued prior to the date of the bidding documents.
- C. Conform to the requirements of all local, state and federal agencies which have authority over the project. Include all items of labor and material required to meet such requirements regardless of the failure to specify in the project manual or indicated on the drawings each individual item.
- D. All equipment, apparatus and systems shall be rated, tested, fabricated and installed with the applicable industry standards.
- E. The applicable portions of the following standards form a part of this project manual to the same force and effect as if repeated herein.
 - 1. American National Standards Institute (ANSI)
 - 2. International Plumbing Code (IPC)
 - 3. American National Standards Institute (ANSI)

4. American Society for Testing Materials (ASTM)
 5. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
 6. American Society of Mechanical Engineers (ASME)
 7. American Water Works Association (AWWA)
 8. National Electrical Code (NEC)
 9. National Electric Manufacturers Association (NEMA)
 10. National Fire Protection Association (NFPA)
 11. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 12. Underwriters Laboratories, Inc. (UL)
 13. Environmental Protection Agency (EPA)
- F. Conform to the International Building Code and International Plumbing Code, 2012 edition.
- G. Conform to applicable sections of NFPA 13, NFPA 20 and NFPA 24.
- H. Conform to the National Electrical Code, 2011 Edition.
- I. Conform to the requirements of the Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) Standard 117.
- J. Conform to Department of Public Health and Environment, Health Facilities and Emergency Medical Services Division, "Standards for Hospitals and Health Facilities".
- K. Conform to requirements of the Facility Guidelines Institute (FGI) "Guidelines for Design and Construction of Healthcare Facilities", 2006 Edition. and the Joint Commission for Accreditation of Healthcare Organizations (JCAHO).
- L. All work shall be furnished and installed in complete accordance with Code seismic requirements.
- M. In case of difference between these specifications, codes, laws, industry standards, and/or utility company regulations the most stringent requirement shall govern.

1.05 EXAMINATION OF BIDDING DOCUMENTS

- A. Each bidder shall examine the bidding documents carefully, and not later than seven days prior to the date of receipt of bids, shall make written request to the Architect for interpretation or correction of any discrepancies, ambiguity, inconsistency, or error therein which he may discover. Any interpretation or correction will be issued as an addendum by the Architect. Only a written interpretation or correction by addendum shall be binding. No bidder shall rely upon interpretations or corrections given by any other method. If discrepancies, ambiguity, inconsistency, or error are not covered by addendum or written directive, Contractor shall include in their bid, labor materials and methods of construction resulting in higher cost. After award of contract, no allowance or extra compensation will be made on behalf of the Contractor due to his failure to make the written requests as described above.
- B. In order to become familiar with the scope of the work involved, visit the existing site, before submitting bid, and carefully examine the existing conditions in order to have full knowledge and understanding of the conditions and restrictions affecting the performance of the work required. Include in bid all work which is reasonably inferred by the contract drawings and specifications, whether specifically shown or not, as a result of existing conditions,

construction, irregularities and interferences which may affect work and is necessary for fully functioning system. No additional compensations will be considered for misunderstanding the conditions to be met.

- C. The person submitting the request will be responsible for its prompt delivery. Failure to so request clarification of any inadequacy, omission, or conflict will not relieve the Contractor of responsibility. The signing of the Contract will be considered as implicitly denoting that the Contractor has a thorough comprehension of full intent and scope of the working drawings and specifications.

1.06 BIDS AND SUBSTITUTIONS

- A. Materials, equipment or services listed by several identifying names are intended to be bidder's choice, and any of the listed names may be bid without soliciting prior acceptance. In all cases where more than one name is given in the specifications, the first named manufacturer's material, equipment or services shall be the basis of design which has been contemplated in coordination and production of the Contract Documents. Where equipment is noted in the drawings or on schedules in the drawings, the manufacturer and model number listed in the schedule shall be considered the basis of design and shall supercede listing order in the specification. Any changes, including spatial requirements, and costs required to accommodate materials or equipment other than the basis of design shall be the responsibility of the Contractor bidding other than basis of design equipment.
- B. If the Contractor wishes to submit a substitute to the named manufacturer(s) for any equipment, they shall submit in writing on Architect's Substitution Request form, prior to bid, stating the manufacturer's name, model number, and detailed product data. In all cases, if the substitute manufacturer is used, the Contractor shall bear all additional costs including, but not limited to, responsibility of coordination with all other trades, any changes incurred in plumbing, electrical, mechanical, general, etc., which result from equipment or material substitution.
- C. Where materials or equipment are specified by name, the proposed material or equipment must be identical to the specified material or equipment in all characteristics of quality, function and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture. Work performed or constructed with unapproved materials/equipment is at Contractor's risk, and any required correction of Work incorporating materials/equipment shall be at Contractor's sole cost and expense.
- D. Performance Specification of Products:
 - 1. Where any product is specified only by requirement to meet an industry standard or regulating body standard such as UL, AGA, AWWA, ANSI, etc. and the item proposed carries approval of that body, no prior acceptance by the Architect / Engineer is needed.
 - 2. When any product or service is specified by requirement to meet a performance standard or is specified by a generic specification, (no manufacturers name listed) no prior acceptance by the Architect / Engineer is needed except as specifically called for in these specifications.
- E. Approval by the Architect / Engineer of equipment other than the specified does not relieve Contractor of this Responsibility.

F. Acceptance

1. In all instances, Contractor shall assume full responsibility for proof of equality of the stature to the equipment hereinafter specified. All data and information necessary for proof of equality, function and space requirements shall be prepared and accompany the submittal of the Substitution Request to the Architect / Engineer.
2. Specified material and equipment shall be considered the basis of design, and while not specifically mentioned, characteristics such as material types, gauges, weights, appearance and space requirements of the basis of design materials and equipment must be met by any proposed substitutions.
3. Action for substitutions specified herein will be given only after the receipt of formal Substitution Request accompanied by complete data showing performance over entire range, physical dimensions and material construction all specifically marked for the individual item in accordance with requirements for Submittals of Product Data.
4. Where the substitution requires any changes in piping, electrical wiring, clear space for service requirement, venting, ducting, submit Coordination Drawings with the Substitution Request indicating changes required and conclusively coordinating changes required for the Fire Suppression Division as well as changes required for all other Divisions. Contractor submitting the Substitution Request shall:
 - a. Be responsible to coordinate all Divisions and make all changes required to accommodate the Substitution.
 - b. Pay for all changes required of both the Fire Suppression Division and all other Divisions to accommodate the Substitution.
5. Approval of the Substitution Request by the Architect / Engineer does not relieve the Contractor of the above responsibilities. See General Conditions for method of notification of acceptance.

- G. In the event the substituted material or equipment does not perform to meet the design intent, fit or meet quality standards, the Contractor shall provide the specified material or equipment and bear all costs to replace the substitute item(s).

1.07 BID ALTERNATE(S)

- A. Refer to Division 01 for items requiring alternate pricing within the contract documents.
- B. Alternate(s) for Materials and Equipment
1. Equipment and material bid alternate(s) shall be proposed as additive or deductive alternate(s) to specified items by submitting it as a separate line item from the base bid on the Bidder's letterhead.
 2. Such bid alternate proposals shall not be substituted or included in the base bid. Bid alternate proposal(s) must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be added or deducted for each item. The bid alternate shall include all materials, equipment, labor, electrical connections, coordination with all other trades, etc. for a complete and operational system.
 3. The Contractor shall submit the bid alternates at the time the base bids are due.

1.08 PERMITS, FEES AND NOTICES

- A. Apply for and pay for all permits, fees, licenses and inspections for this Division of work.

1. Do not include the cost of any "Plant Investment Fee" or "System Development Charge" for sewer and/or water charged by the City. This will be arranged for and paid for by the Owner.
 2. Do not include the cost of any "Gas Application Fee" charged by the Utility Company. This will be arranged and paid for by the Owner.
- B. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.

1.09 PLANS AND SPECIFICATIONS

- A. The intention of the plans and specifications is to provide all piping, fixtures, and equipment. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Wherever the term "provide" is used, it shall mean "furnish and install".
- B. All plans and specifications including architectural, interiors, site, structural, electrical, plumbing, fire suppression, and HVAC plans shall be examined by Contractor prior to submission of quotations to determine systems interface and conditions which could cause interference or deviations in equipment locations and routing. Errors or discrepancies on plans or in specifications shall be reported to the Architect/Engineer in writing and written instructions obtained for the discrepancy prior to submittal of bid to the Owner.
- C. All changes from the plans necessary to make the work conform to buildings as constructed and to fit work of other trades, or to conform to rules of all governing authorities and regulations, shall be met by each Contractor without extra cost to the Owner.
- D. Routing of piping and location of equipment and other devices are shown on plans in a diagrammatic manner for general guidance. Plans shall not be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings, and from the structure itself before fabricating any work. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect, or Engineer.
- E. Manufacturer's drawings and instructions shall be followed in all cases where the makers of devices and equipment furnish directions covering point not shown on the drawings or described in the specifications. Install all equipment in accordance with manufacturer's recommendations, unless approval is given in writing by the Engineer for deviation.
- F. Layout and installation of fire suppression work shall be coordinated with the overall construction schedule of various trades to prevent delay in completion of the project. Complete drawings and specifications for the entire job shall be maintained and updated at the job site. Coordinate the fire suppression work with and be responsible to the General Contractor for satisfactory progress of the work. Coordinate fire suppression work with all other trades on the project without additional cost to the Owner.
- G. Priority of interpretation of discrepancies in Contract Documents shall be complimentary from specifications to drawings. Where discrepancies occur between various specifications, drawings and specifications or codes and standards, the most demanding requirement shall take

precedence, except where written interpretation from the Architect/Engineer indicates otherwise.

- H. All work and materials covered by drawings and specifications shall be subject to review at any time by representatives of the Architect and Owner. If the Architect or Owner's agent finds any materials or installation that does not conform to these drawings and specifications, Contractor shall remove the material from the premises and correct the installation to the satisfaction of the agent.
- I. In acceptance or rejection of installed mechanical systems, no allowance will be made for lack of skill on the part of the installers.

1.10 SUBMITTALS

A. General

- 1. Submit under provisions of Division 01 and the requirements below.
- 2. The purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect / Engineer that the Contractor understands the design concept. Contract shall demonstrate their understanding by indicating which equipment and material they intend to furnish and install, and shall detail the fabrication and installation methods they intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and contract documents are discovered either prior to or after shop drawings and specifications shall control and shall be followed.
- 3. Review of Submittals is rendered as a service only and shall not be considered as a guarantee of measurements or of building conditions; nor shall it be construed as relieving the Contractor of basic responsibilities under their Contract. Architect / Engineer will check submittals only for conformance with the design concept of the project. Review shall not be construed as:
 - a. Permitting any departure from the contract requirements.
 - b. Relieving the Contractor of the responsibility for any error in details, dimensions or otherwise that may exist in the Shop Drawings.
 - c. Contractor agrees that shop drawing submittals processed by the Architect / Engineer are not change orders.
- 4. Submittal Schedule: Generate a Schedule of anticipated initial submittals for this Division and provide to General Contractor. Include in schedule specified durations time for review, submittal revision, resubmittal, and subsequent review as indicated in Division 01. Structure submittal schedule to allow for construction and delivery long lead and critical path items based on the overall project construction schedule. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet construction schedule, together with any special handling charges, shall be borne by the Contractor.

B. Shop Drawings

- 1. Proposed Product List: At the onset of Project's submittal phase, this Contractor shall submit a complete list of all material and equipment they propose to use in the installation. This list shall include all products specified in this Division and indicate manufacturer, catalog numbers and other identifying information. Architect / Engineer

reserves the right to not review individual Product Data and Shop Drawing submittals until the Proposed Product List has been submitted and reviewed.

2. After review of the Proposed Product List by the Architect / Engineer, the Contractor shall submit Product Data and Shop Drawings including descriptive literature of the equipment to be provided under this contract. Drawings shall state capacities, sizes, etc., of all equipment and shall be certified.
3. The shop drawings shall be reviewed by the Contractor and stamped and signed certifying they have reviewed and found them to be 100% complete and accurate, prior to submission. Mark project name and location on each shop drawing, catalog cut and/or specification sheet along with Contractor's signed stamp. Architect / Engineer reserves the right to reject shop drawings submitted without project name, location or stamp of Contractor's review.
4. Clearly mark each shop drawing, catalog cut and/or specification sheet to indicate those products and features which are intended to be furnished. Use highlights, arrows, underlines, circles and strikethroughs to identify exact features, options, capacities, characteristics and dimensions of equipment to be provided. Strike through information that does not apply to the intended product, options not intended to be included, and any manufacturer's disclaimers such as "Dimensions Subject to Change Without Notice." Options not specifically struck will be understood to be included. Architect / Engineer reserves the right to reject shop drawings not adequately marked in the above manner.
5. Review and approval of shop drawings shall not relieve the Contractor from the responsibility of furnishing equipment and materials of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents. Review and approval does not relieve the Contractor from responsibility for errors on the shop drawings. If the shop drawings deviate from the contract documents, Contractor shall advise the Architect / Engineer of such deviations in writing accompanying the shop drawings submittal, including the reasons for the deviations. Coordinate all required changes with the other trades affected. If the changes are occasioned by the Contractor, they shall pay any costs involved.

C. Coordination Drawings

1. This Contractor shall provide the support role in development of a combined set of coordination electronic drawing(s) to conclusively coordinate spatial arrangements of their materials and equipment with all other trades, and to define sequencing and coordination of installations for efficient flow of the Work. Coordination drawings shall be minimum scale of 1/4" = 1/0" along with a detailed 3-D model showing locations, dimensions and height of installation of all major pieces of equipment, ductwork and piping provided under their respective contracts. Drawings shall include the following:
 - a. Bottom of duct height and size
 - b. Piping elevations and size
 - c. Power and Data Conduit elevations and size
 - d. Hanger support locations (Ductwork / Piping / Conduit / Cable Tray)
 - e. Lighting devices
 - f. Telecom / Security
 - g. Fire Protection mains/branch lines/head placement with elevations and size
 - h. Building structure background
 - i. Proposed locations for access panels (Ductwork/Piping/Conduit/Cable Tray)
 - j. Indicate the locations of all equipment and materials, including clearances required for servicing and maintaining equipment.

- k. Indicate movement and positioning of large equipment into the building during construction.
 2. Order of space preference throughout the building shall be:
 - a. Recessed light fixtures
 - b. Ductwork
 - c. Soil, Waste, vent and storm piping
 - d. Domestic water piping
 - e. Sprinkler piping
 - f. Electrical conduit
 - g. Exception: Plumbing lines below or behind plumbing fixtures shall have precedence over all other work. Electrical conduit above or below switchgear, panel boards and control panels shall have precedence over all other work. Do not install any fluid conveying piping over electrical or elevator equipment
 3. Prepare and submit the coordination drawings including detailed three dimensional model for review. By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.
 4. The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittals has been approved by the Engineer.
 5. Where Contractor has failed to provide proper space for equipment and required clearances (as required by local AHJ, as related to code requirements, as noted or shown on plans or as noted on submittals) Contractor shall relocate the equipment as directed by Engineer. Contractor shall be held responsible for any and all changes resulting from such relocations and shall be held responsible for any and all changes resulting from such relocations and shall bear any and all increase costs to Contractor as well as costs to other trades in making said revisions.
- D. Architect / Engineer's Review of Submittals:
 1. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect / Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect / Engineer in writing of such deviation at the time of submittal and the Architect / Engineer has given written approval of the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings Product Data, Samples or similar submittals by the Architect / Engineer's approval thereof.
 2. Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.
 3. The Architect / Engineer will review and approve or take other appropriate action upon contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect / Engineer's action will be taken with such reasonable promptness as to cause no delay in the Work of the Contractor or in the activities of the other Contractors, the Owner, General Contractor, or

the Owner's Representative, while allowing sufficient time in the Architect / Engineer's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation of performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect / Engineer's review of the Contractor's submittals shall not relieve the Contractor of the obligations per the Contract Documents.

1.11 EXISTING UTILITIES

- A. The plans indicate the location, type and sizes of various utilities within the site where known. These utilities are indicated as accurately as possible. If utilities are encountered during construction, which are not shown on the drawings, ask for instructions from the Architect. Any relocation or remodeling required will then be directed by change order. Assume all responsibility for protection of all utilities, shown or not, and repair any damage caused by this construction at no extra charge to the Owner.
- B. Investigate with proper authorities for all existing water taps, etc. and make arrangements to pay for all removal charges in original bid.
- C. Owners of all underground utilities shall be notified prior to excavation so that they can locate and mark underground utilities.

1.12 FIRE PROTECTION INSTALLATIONS

- A. Coordinate fire protection equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for fire protection installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of fire protection materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install fire protection and overhead equipment to provide the maximum headroom possible, and in accordance with minimum required clearances as specified in codes and regulations.
- H. The word "concealed" as used in this specification refers to such spaces as pipe and duct chases, pipe and duct trenches, above plastered ceilings, in walls and buried where pipe and/or duct is inaccessible when building is complete. "Exposed" is intended to be within equipment rooms, unfinished areas, above "push up" ceilings, accessible pipe and duct tunnels.

- I. The term “furnish” means supply and deliver to Project, unless otherwise defined in greater detail. The term “install” is used to describe operations at Project, from inspecting and unloading, to completion in place, ready for intended use. The term “provide” means furnish and install, complete and ready for intended use, unless otherwise defined in greater detail.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Use only new materials, of the best quality of their respective kinds.
- B. All materials, in general, shall be Underwriter's Laboratories listed and labeled.

2.02 EQUIPMENT MANUFACTURER

- A. Equipment in the following categories shall be of one manufacturer or available through one manufacturer for each category to facilitate ease of maintenance for the Owner.
 - 1. Access Doors
 - 2. Motors (open drip-proof squirrel cage)
 - 3. Fire Suppression Fixture Trim
 - 4. Pressure Gauges
 - 5. Starters
 - 6. Strainers
 - 7. Thermometers
 - 8. Valves

PART 3 - EXECUTION

3.01 ENGINEERING BY CONTRACTOR

- A. The construction of this building requires the contractor to design several systems or subsystems. All such design shall be the completed responsibility of the contractor. Hangers, supports and seismic restraint systems and design details are hereby delegated to the contractor to design, detail, and submit with seal of Registered Professional Engineer for review by Architect / Engineer.

3.02 SAFETY AND MAINTENANCE OF WORK AREAS

- A. The Engineer has no contractual responsibility in connection with job site safety measures or precautions as related to means, methods, techniques, sequences or procedures. Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Architect/Engineer's observations of the Contractor's performance are not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site. Contractor shall be responsible for providing all such safety measures and shall consult with the Local, State or Federal Safety Inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist; or whether he is or is not in compliance with Safety Regulations.

- B. During the project, this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project

3.03 HANDLING AND STORAGE OF MATERIALS AND EQUIPMENT

- A. Provide for proper storage of all materials and equipment and assume responsibility for losses due to any cause. All storage shall be within the contact limit lines of the building site. Cover and store all equipment and materials out of elements; any rusted or weather damaged item shall not be used.
- B. It is recognized that space at the project for storage of materials and products is limited. Coordinate the deliveries of fire suppression systems materials and products with the scheduling and sequencing of the work so that storage requirements at the project are minimized. In general, do not deliver individual items of equipment to the project substantially ahead of the time of installation. All materials shall be covered prior to installation and protected until final acceptance.

3.04 COORDINATION AND INSTALLATION OF THE WORK:

A. COORDINATION AMONGST TRADES:

1. This Contractor shall provide a qualified person during the construction phase of the shop drawing development that has the skills to convert the diagrammatic project drawings into composite assembly drawings in the CAD format determined by the Mechanical Contractor, for integration of systems into the combined master per floor coordination documents being assembled by the Mechanical Contractor. These coordination / fabrication drawings will conform to the performance criteria identified in the project documents and will fit into the 3 Dimensional allotted space for all systems. Where the piping dimensions, sizes and general arrangements of elements will require to be adjusted due to coordination of new or existing building structure, Architect's reflected ceiling plan and other trade's materials and or equipment space needs, qualified person will provide proposed recommendations of sizes, elevation changes, offsets, etc. for inclusion in a combined drawing(s) for the coordination meetings that will be reviewed by the Architect, Engineer, Owner and other trades to provide an overall acceptance of coordination per floor.
2. The layout shown on the drawings is necessarily diagrammatic but shall be followed as closely as other work will permit. Changes from these drawings required to make this work conform to the building construction shall be made only with prior written approval of the Architect/Engineer. All proposed changes shall be shown on shop drawings. All measurements shall be verified by actual observation and all work shall fit in place meeting the approval of the Architect/Engineer.
3. Provide openings required in new and existing construction that may be necessary. All patching and repairing shall be done by workmen competent in the trade required, at the expense of this Contractor. Arrange work so that minimum cutting will be required. All rubbish and excess materials involved in such cutting shall be promptly removed from the site and disposed of. Cutting through the floor or roof systems or load bearing walls shall be done only with the prior written approval of the Architect/Engineer so as to avoid damaging the structural system.

B. SEQUENCING, SCHEDULING:

1. Confer with the other contractors regarding the location and size of pipes, equipment, ducts, openings and special architectural treatments in order that there may be no interferences between the installation or the progress of the work of any contractor on the project.
2. In the case of interconnection of the work of two or more contractors, verify at the site or on shop drawings all dimensions relating to such work. All errors due to the failure to so verify any such dimensions shall be promptly rectified.
3. Access panels, in walls or ceilings, required (i.e., automatic or manual damper, fire or smoke damper, coil or control instrument mounted in a duct or pipe) shall be provided by the respective contractor and installed by workman competent in the trade required at the expense of this Contractor. Access panels are not required in areas where the ceiling system is lay-in tile; however, sufficient space must be available in and through the ceiling system to allow maintenance and adjustment of dampers, and cleaning of coils as necessary, or a suitable access panel shall be provided for that purpose. Access panels shall be approximately 24 inches by 24 inches wherever possible and shall be provided with flush trim and an allen-key operated camlock fastener. Submit manufacturer's product data to Architect for approval.
4. Items of equipment may be specified in the singular however, provide and install the number of items of equipment as required for a complete system.
5. Provide excavating, pumping, backfilling and compacting required, as shown on the drawings.
6. Equipment and devices which have factory prime coat or final surface finish shall be replaced, repaired or refinished if defective or damaged during installation.
7. Arrange all work so a minimum period of interruption or outages will occur in the temporary or permanent transfer of services as required for all electrical revisions. Not less than two (2) weeks notification to the Using Agency/Owner shall be required before approval will be granted for any disruption of services. The outage request shall include the extent of the work to be done, length of outage time required and the time at which the outage is to begin. No allowance will be made for extra payment as a result of scheduling "overtime" work necessary to perform before or after normal or regular working hours to accomplish the work intended.
8. Submit a "Sequence of Work Schedule" in respect to all temporary and permanent utility and service cutovers after final determination. This schedule shall be submitted for approval to the Architect/Engineer. The submittal shall designate priority order, service or utility affected, date of cutover, and time of day to start and finish.

C. MANUFACTURER'S INSTRUCTIONS

1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. All items which are a source of noise generation and/or mechanical vibration shall be installed with proper attenuation provisions including absorbers, isolators, or mufflers as required to prevent objectionable noises and vibrations.
4. If a conflict exists, notify the Architect/Engineer in writing and obtain instruction before proceeding with the work in question.

D. HOISTING AND MOVEMENT OF EQUIPMENT

1. This Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.
2. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
3. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.
4. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
5. Where mechanical products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

E. CONCRETE

1. All poured in place concrete required for equipment furnished under this Division shall be furnished & installed by this Division in accordance with requirements specified under the Architectural Divisions of these Specifications.
2. Concrete pads shall be minimum 4 inch high and anchored to the floor with dowels.

F. CLEARANCES

1. Install piping and equipment:
 - a. Straight and true.
 - b. Aligned with other work.
 - c. Close to walls and overhead structure (allowing for insulation).
 - d. Concealed, where possible, in occupied spaces.
 - e. Out-of-the-way with maximum passageway and headroom remaining in each space.
 - f. Conceal all piping in finished areas of the building except where otherwise noted on the drawings.
2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:
 - a. 7'0" headroom in storage spaces.
 - b. 8'6" headroom in other spaces.
3. Do not obstruct windows, doors or other openings.
4. Give the right-of way to piping systems required to slope for drainage (over other service lines and ductwork).
5. Offsets, transitions and changes in direction in pipes shall be made as required to maintain proper head room and pitch of sloping pipes whether or not indicated on the drawings. Furnish and install all traps, air vents, sanitary vents, etc., as required to affect these offsets, transitions and changes in direction.

G. ACCESS AND ACCESS DOORS

1. Install all work to permit removal (without damage to other parts) of coils, heat exchanger bundles, boiler tubes, fan shafts and wheels, filters, belt guards, sheaves and drives, and all other parts which might require periodic replacement or maintenance. Arrange pipes and equipment to permit ready access to valves, traps, starters, motors, control components and to clear the openings of doors and of access panels. Furnish access panels for all mechanical equipment and valves requiring access in concealed locations for installation by contractor.

2. Provide shop drawings to the Architect and Engineer showing locations of all access panels.
3. Furnish access doors of type suitable to Architect and provide to General Contractor to construct into the building. Access doors should be provided in all locations where access is required.
4. Provide painted, steel (unless noted otherwise) access doors with key lock suitable for the surface in which they are installed and satisfactory to the Architect.
 - a. Plaster finish walls and ceilings: Recessed style.
 - b. Acoustical tile ceilings: Recessed type.
 - c. Drywall walls and ceilings: Flush panel.
 - d. Remodel Applications: Flanged flush panel.
 - e. Corrosive environments, including but not limited to, restrooms, locker rooms, pool equipment rooms, and natatoriums: Panel and frame shall be aluminum or stainless steel. All associated hardware and fasteners shall be stainless steel.
 - f. Panels in fire and/or smoke rated assemblies shall be listed for the application and carry the appropriate rating for the assembly in which they are installed.

3.05 SEISMIC ANCHORAGE AND BRACING

- A. All equipment and piping shall be braced, restrained, anchored or sway braced to resist a seismic event; as required by Chapter 16 of the 2006 International Building Code, NFPA 13, and ASCE 7-05. Refer to Structural Drawings for Design Spectral Response at Short Periods. Consider the building Occupancy as Category IV. Consider all piping, equipment, and systems installed under this Division as crucial for the continued operation of the facility after a seismic event and are thus assigned an $I_p = 1.5$ Importance Factor. Refer to structural drawings for additional detailed information regarding Seismic Design Category, design accelerations, etc.
- B. Contractor shall submit with equipment and piping shop drawings all required anchorage, bracing and restraints complete with calculations/details designed by a Registered Structural Engineer, and Engineers' Seal and Signature shall be affixed thereto.
 1. Contractor shall be responsible to obtain and provide all anchors, supports, etc. necessary for all code agency approvals.
 2. Piping may also be restrained by prefabricated supports; Midland Ross Corporation, Superstrut Universal seismic supports; Kin-Line Inc., seismic restraint system; B-Line seismic restraints; TOLCO seismic restraints; or any other pre-approved system recognized by the city/county, state codes; provide proof of compliance.

3.06 PROTECTION OF WORK AND PROPERTY

- A. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work of Owner's operation.
- B. Close all pipe openings with caps or plugs during installation. Cover all fixtures and equipment and protect against injury. At the final completion, clean all work and deliver in an unblemished condition, or refinish and repaint at the discretion of the Architect.
- C. Any equipment or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Architect / Engineer's satisfaction.

- D. Initial fill of traps: Provide initial water seal fill for all waste p-traps, condensate traps, or similar traps.

3.07 PROTECTION OF POTABLE WATER SYSTEMS

- A. All temporary water connections shall be made with an approved back flow preventer.
- B. All hose bibbs shall have, as a minimum, a vacuum breaker to prevent back flow.
- C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.08 TEMPORARY HEAT, VENTILATION, AND AIR-CONDITIONING

- A. Temporary heat, ventilation, and air-conditioning (HVAC), if required for the construction activities, shall be furnished by the General Contractor. Use of the permanent HVAC system shall not be allowed without written authorization from the Engineer. In the event the permanent HVAC systems are desired to be used prior to substantial completion and final cleaning, the General Contractor shall meet all requirements of the Engineer's written authorization and shall pay all utility costs for operation of the HVAC systems until acceptance by the Owner.

3.09 ELECTRICAL EQUIPMENT AND WIRING FOR FIRE SUPPRESSION DIVISION

- A. Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule. (FD is Fire Suppression Division - ED is Electrical Division).

Type	Furnished Under	Set in Place by	Wired & Connected by
Equipment Motors and Thermal overloads, resistance heaters (C)	FD	FD	ED
Motor Controllers; magnetic starters, reduced voltage starters and overload relays.	FD	ED(A)	ED
Disconnect switches, fused or unfused, H.P. rated switches, thermal overload switches and fuses, manual operating switches.	ED(A)	ED(A)	ED
Push-button stations, pilot lights, multi-speed switches, float switches, thermostats, control relays, time clocks, control transformers, control panels, motor valves, damper motors, solenoid valves, EP and PE switches and interlocks	FD	FD(B)	FD(B)
120 volt power for Building Automation System (BAS) panels, fire protection and boiler controls	ED	ED	ED

3.10 Notes:

- A. If furnished as part of factory wired equipment, wiring and connections only by ED.
- B. If any of these devices carry the full load current to any motor or resistive element(s) they shall be connected by ED. Control devices carrying full load current furnished by FD and wired by

ED shall be located at the device being controlled, unless shown on drawings or mutual agreement is made between the contractors with no change in the contract price.

- C. Wiring from alarm contacts to alarm system by ED; all control function wiring by FD. Duct detectors furnished by ED, set in place by FD.

3.11 GENERAL NOTES:

- A. The above list does not attempt to include all components. All items necessary for a complete and operable system shall be included in the base bid.
- B. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connectors.

3.12 FLUSHING, CLEANING & STERILIZING

- A. Intent: It is the intent of this specification to require that all work, including the inside of equipment, be left in a clean condition with all dust, grease, and construction debris removed.
 - 1. Piping and connection equipment to be left free of sediments, core sand, grease, etc.
 - 2. Clean all exposed surfaces of piping, ducts and hangers, etc., sufficiently to receive paint.
 - 3. Remove and clean all screens, interceptors, strainers, etc., in piping systems just prior to substantial completion.
 - 4. Clean and wipe dry all plumbing fixtures, exposed valves, and piping, etc. that are exposed just prior to substantial completion. Clean all equipment and fixtures per manufacturer's specifications to avoid scratching finished surfaces.
 - 5. Thoroughly clean all equipment room floors after completion of equipment, pipe and duct cleaning. A condition of final acceptance will be the cleanliness of all exposed systems, equipment, and equipment rooms.
- B. Before final connections are made in the piping systems, blow out all piping with air and then wash out with cleaning compounds. Then flush the system to remove of all foreign materials. Furnish all temporary connections, valves, etc, required for this purpose.

3.13 TESTING

- A. Test all high domestic water service lines to PRV, fire lines and anti-freeze piping at 200 psig hydro static pressure.
- B. Test all air, oil and gas piping under 60 psig air pressure.
- C. All tests must be done to the satisfaction of the local authorities having jurisdiction, before covering.
- D. All hydrostatic tests to be held for a minimum of six hours without loss of pressure. Air tests to be held for a minimum of two hours without loss of pressure.
- E. Furnish all instruments required for testing.

3.14 EQUIPMENT START UP AND PLACING IN OPERATION

- A. Clean all pipes, equipment, controls etc., of plaster and other foreign debris. Clean or replace all strainers.
- B. All packaged fire suppression equipment shall be started by the manufacturer or under the manufacturer's supervision. Start-up data shall be recorded in logs. Copies of start-up logs shall be forwarded to the Engineer and included in Operation and Maintenance manuals.

3.15 CLEANING

- A. Immediately prior to inspection for Substantial Completion, remove any remaining waste materials and rubbish from mechanical and electrical rooms. Remove protective coating, barriers and other protective devices, temporary work, and surplus materials.
- B. Leave mechanical rooms and similar unfinished spaces "Broom Clean." Dust equipment, pipes, and other work in mechanical rooms and similar unfinished spaces. Remove construction dirt and debris from interior of equipment, panels, disconnects, ductwork, etc. thoroughly in accordance with manufacturer's instructions.
- C. Upon completion of the contract all remaining materials and rubbish shall be removed from the building and premises and the work areas shall be left clean and free from stains, mortar, paint spots, etc.
- D. Upon completion of the work, put systems into service maintaining responsibility for the equipment during all testing operations including the lubricating and turning on and off of such apparatus

3.16 CLOSEOUT SUBMITTALS

- A. OPERATION AND MAINTENANCE INSTRUCTIONS
 - 1. Books of Operating and Maintenance Manuals shall be delivered to the Owner's authorized representative and the Owner instructed as to their use and the equipment involved.
 - 2. Thirty (30) days Prior to Substantial Completion, submit operating and maintenance manuals for equipment to Engineer for approval. Assemble manuals into white, 3-ring binders. Insert laminated cover sheets, identifying each binder on the front and spine with all necessary information so that all volumes appear uniform and orderly (i.e. Project Name, Owner Project Number, Contractor/Architect/Engineer Information, Volume Number, General Contents Description such as Mechanical, Electrical, etc.)
 - 3. Provide comprehensive table of contents indicating the contents of all volumes in each set. Organize and tab documents in an orderly sequence, based on the table of contents of the project manual. Within each section, organize alphabetically by system or subsystem. Include a section in the directory for each of the following: list of documents, list of systems, and list of equipment.
 - 4. Include copy of each submittal, including Architect / Engineer's review comments, and subsequent resubmittals for record purposes, indicating the actual product installed. Include significant changes in the product delivered to project site and changes in manufacturer's written instructions for installation.

5. Provide organized warranty section in the lead binder (Contractor's option to provide separate binder.) Organize warranty documents into an orderly sequence in separate binder, based on the table of contents of the project manual. A copy of each warranty shall also be provided in the respective equipment section.
6. Provide organized equipment failure emergency section in the lead binder (Contractor's option to provide separate binder.) Organize into separate sections for each type of emergency and include all necessary steps for safe equipment shut-down and containment. Also, include all necessary contractor and vendor contact information including 24-hour call numbers.
7. Provide comprehensive contact list in the lead binder including contractor and subcontractor's names, addresses, telephone and contact person for Owner's use.
8. Include equipment start up logs for all equipment required to be checked out and initially started under manufacturer's supervision.
9. Provide manufacturer's complete data sheets including assembly drawings, spare parts lists, wiring diagrams, mechanical diagrams, installation diagrams, and instructions. Identify equipment in manual and cross-reference by including serial number of actual components.
10. In addition to Manufacturer's maintenance documentation, provide separate schedules for preventative and routine maintenance and service with standard time allotment. Include service and lubrication requirements and list of required lubricants for equipment, application methods and frequencies.
11. Provide Preventative Maintenance (PM) schedule for checking all items such as belt drives, safety controls, motor running load amps, oil, refrigerant and grease charges. Include cleaning schedule of all strainers, traps, coils, tubes, etc.
12. Include record of spare parts provided including signature of Owner's representative showing acceptance of parts. Provide list of additional items recommended to be stocked as spare parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and including local sources of maintenance materials and related services.
13. Provide test reports from manufacturer start-up indicating systems to be operating properly, including TAB reports, thermographics surveys, etc.
14. Provide electronic copy of final operation and maintenance manuals in full color pdf format on CD/DVD. All files shall clearly indicate specific information related to actual products installed. File structure and naming shall be "user-friendly" and organized in a manner similar to the hard copy binders such that it may be intuitively navigated by users.
15. Approval will not be given for final payment until the tests, balancing and operating instruction portions have been completed.

B. AS-BUILT DRAWINGS

1. During the process of the work, maintain an accurate record of the installation of the mechanical systems.
2. At the completion of the Work, Engineer shall furnish Contractor with a complete set of the latest revised record drawings in reproducible form, and Contractor shall indicate thereon all as-built changes and such additional details necessary or appropriate to provide a complete reference document for use by Engineer. If variations and details cannot be shown clearly thereon, the Contractor shall prepare supplemental drawings adequate to impart the information. These additional drawings shall also be in reproducible form. The foregoing drawings collectively shall constitute the "As-Built" drawings for the Work.

3. All indications on "As-Built" drawings shall be executed in a legible manner at Contractor's cost, using methods and legend presentations compatible with the overall scheme of the record Drawings with respect to scale, drawing sheet sizes and sequential indexing. All changes shall be marked clearly in red and clouded.
4. Engineer shall review Contractor's "As-Built" drawings and notify Contractor of observed discrepancies or deviations. Contractor shall promptly correct and resubmit revised drawings for Engineer review. Completed "As-Built" drawings shall be delivered to Owner through Architect.

C. DEMONSTRATION AND TRAINING

1. Refer to Division 01 for additional requirements regarding Demonstration, Training, and O&M Manuals submittals.
2. Prepare and submit operating instructions, as required by Specification Sections, and instruct Owner's personnel in use and maintenance of operating equipment. Explain use operation of each system to the Owner's designated representative(s). Explain use of the O&M manuals in operating and maintaining the systems.
3. After installation is complete, schedule to meet and instruct Owner's designated personnel in use, operation, care, and cleaning of equipment. Demonstrate that each system operates properly. Instructions shall be given only by qualified personnel, thoroughly familiar with use and maintenance of equipment.
4. Notify the Engineer in writing a minimum of 72 hours in advance of any scheduled Owner equipment training. Following all training, provide record of Owner training including the type of training, who conducted the training, and list of attendees. Include copy in each set of O&M manuals.
5. Owner training sessions shall be video recorded to DVD media. DVD's shall be clearly labeled indicating content of equipment covered by training, and copies provided as follows: one (1) copy to the Owner, one (1) copy to the Engineer, and one (1) copy shall be included in each set of O&M manuals.

D. WARRANTY

1. Guarantee all work including labor, material and equipment for this project for a period of one year from date of acceptance by Using Agency/Owner. Repair or replace any work found defective without cost to the Owner during the warranty period.
2. All materials and equipment shall be new unless otherwise specified.
3. Guarantee all workmanship, materials and equipment and replace any found defective without cost to the Owner, for one year after final acceptance, as defined in General Conditions.
4. Each warranty for longer than the one year described above (that comes with equipment used on the job) shall be passed on to the owner with dates of start and end of the warranty.

END OF SECTION 22 0010

SECTION 21 0116 - DEMOLITION OF FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of the Fire Protection systems including
 - a. Fixtures, sprinklers, etc
 - b. Piping
 - c. Equipment
 - 2. Temporary protection of Spaces undergoing Renovation.
 - 3. Abandoning in-place below-grade construction.
 - 4. Disconnecting, capping or sealing, and abandoning in-place site utilities.
 - 5. Salvage of existing items for reuse or recycling by Owner.
- B. Related Sections:
 - 1. Section 01 000 "Summary" for use of the premises and phasing requirements.
 - 2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
 - 3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
 - 4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

1.03 DEFINITIONS

- A. Abandon In-Place: Disconnect existing component from service and label as abandoned, but do not remove. Distribution systems and networks such as piping that are abandoned in place shall be labeled abandoned at intervals specified in Division 21 Section "Identification for Fire Protection".
- B. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
- C. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.
- D. Remove and Reinstall: Detach items from existing construction, clean, prepare for reuse, and reinstall where indicated.

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

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated in this section or in the drawings, demolition waste becomes property of Contractor.
- B. Items of Value. Remove and Salvage items of value to the Owner for re-use, shelf-stock, or scrap recycling value as follows. Carefully remove, sort and place in location identified by Owner that is separate from items to be disposed:
 - 1. Copper piping. Stockpile in location identified by Owner separate from items to be disposed.
 - 2. Pre-action valves, dry valves, and associated trim assemblies. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for infection control measures, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of Construction Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
- C. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- D. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before the Work begins.
- E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.06 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.07 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

- C. Pre-demolition Conference: Conduct conference at Project Site.
 - 1. Inspect and discuss condition of construction to be demolished.
 - 2. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review and finalize protection requirements.
 - 4. Review procedures for noise and infection control measures.
 - 5. Review procedures for protection of adjacent buildings.
 - 6. Review items to be salvaged and returned to Owner.

1.08 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to demolition area. Conduct demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with Fire Protection systems demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Fire Protection System Continuity of Service: Owner will occupy portions of the building immediately adjacent to and concurrent with the Renovation Project. Maintain existing fire protection systems in service and protect those elements against damage during selective demolition and construction renovation operations.
 - 1. Immediately upon removal of ceiling systems, modify sprinkler systems to maintain NFPA 13 compliant sprinkler head type, spacing and arrangement to address removal of ceiling.
 - 2. Upturn sprinkler arm-overs and change existing sprinkler heads to upright type.
 - 3. Position uprights within maximum allowable distance of construction assembly above based on construction type, geometry and account for presence of existing obstructions in accordance with NFPA 13.
 - 4. Add sprinklers beneath any existing ducts and similar items 48 inches wide or larger to protect beneath such obstructions for the duration ceiling systems are removed.
 - 5. Coordinate fire watch of the space during the interim period in which ceiling systems are removed and temporary sprinkler systems modifications are not yet completed and placed in service.
 - 6. Maintain fire-protection facilities in service during the entire duration of selective demolition operations and construction renovation activities.

1.09 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
 - 1. [Insert warranted system].
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- B. Examine existing sprinkler arrangements, service valve locations, zoning and above ceiling conditions in advance of scheduled ceiling demolition in preparation for immediate modifications required to maintain Fire Protection Systems Continuity of Service during construction renovation.
- C. Verify that utilities have been disconnected and capped before starting demolition operations.
- D. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations. Comply with Section 013233 "Photographic Documentation."
- E. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.02 PREPARATION

- A. Existing Services/Systems: Locate, identify, disconnect, and seal or cap off indicated systems serving areas to be demolished.
 - 1. Arrange shut off of systems/service with Owner.
 - 2. If systems/services are required to be removed, relocated, or abandoned that will affect adjacent occupied/operational portions of the building(s), then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.

3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
- B. Existing Utilities: See civil and electrical Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- C. Salvaged Items: Comply with the following:
 1. Clean salvaged items of dirt and demolition debris.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to storage area designated by Owner.
 5. Protect items from damage during transport and storage.

3.03 UTILITY SERVICES AND FIRE PROTECTION SYSTEMS

- A. Modify sprinkler systems to maintain Fire Protection Systems Continuity of Service immediately upon removal of ceiling systems. Maintain fire watch for the duration between removal of ceiling systems and placing back into service the modified sprinkler arrangements accounting for protection of the temporary condition in which ceiling system are removed to account for renovation activities.
- B. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."
- C. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 3. Disconnect, demolish, and remove Plumbing systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Label entire extents of system abandoned in place in accordance with Section 210553 "Identification for Fire Suppression Systems".
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.04 PROTECTION

- A. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
 - 1. Do not interrupt existing utilities serving operating facilities unless authorized in writing by Owner.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.
 - a. Provide at least 10 days notice to occupants of affected buildings if shutdown of service is required during changeover.

3.05 DEMOLITION, GENERAL

- A. General: Demolish indicated systems completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and for at least 8 hours, or duration required by Owner and Fire Marshal, after flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

3.06 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of Fire Protection systems systematically, from lower to higher level. Complete Fire Protection systems demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Below-Grade Construction: Abandon below-grade construction. Cut below-grade construction below grade, cap, and grout flush with grade.

- D. Existing Utilities: Demolish and remove existing utilities, below-grade tanks, and below-grade utility structures.
 - 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 - 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.07 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.
- B. Repair fireproofing where hangers and supports have been removed.
- C. Patch holes and openings in walls, floors, ceilings and structure created by removal of piping.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3.09 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.10 SELECTIVE DEMOLITION SCHEDULE

- A. Existing Items to be Removed: All fixtures, piping and equipment as indicated in drawings.
- B. Existing Items to be Removed and Salvaged: Items of monetary value to the Owner as follows:
 - 1. Fire protection valves and trim deemed of salvage value, or otherwise deemed valuable to the Owner as service stock for like fixtures to remain elsewhere in unrenovated portions of the facility.
 - 2. Copper piping, insulation completely removed, straight lengths bundled and palletized ready for recycling, brass and bronze specialties need not be removed.
- C. Existing systems to be Abandoned In-Place: Specifically noted on drawings. Typically limited to distribution piping located in portions of the building where removal is not economically viable. Label systems as abandoned at intervals specified in Division 21 Section "Identification for Plumbing".
- D. Existing items to Remove and Reinstall: Specifically noted in drawings.
- E. Existing systems/services and items to Remain: All system not specifically noted as removed, demolished, or abandoned in place shall be considered existing to remain.

END OF SECTION 21 0116

SECTION 21 0517 - SLEEVES AND SLEEVE SEALS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2-inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or outer dimension of pipe insulation for insulated pipe. Coordinate sleeve sizes with requirements of Section 23 0711 "Insulation".
 3. Increase sleeve size as required to provide additional annular space for project specific seismic conditions. Coordinate sleeve sizes with requirements of Section 23 0548 "Vibration and Seismic Controls".
 4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 9200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.02 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
 2. Exterior Concrete Walls below Grade:
 - a. Piping, All sizes: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Piping, All sizes: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 4. Concrete Slabs above Grade:
 - a. Piping, All sizes: Stack-sleeve fittings.
 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 0517

SECTION 21 0518 - ESCUTCHEONS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 0518

SECTION 21 0529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 0548 - Vibration and Seismic Requirements For Fire Suppression

1.02 WORK INCLUDES

- A. Base Bid: Hangers and supports of plumbing piping and equipment are considered delegated design by Contractor. Design, Furnish and Install hanger and support systems for Plumbing Piping and Equipment as part of the Base Bid.

1.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Steel Equipment supports.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural support and anchor design detailing is the responsibility of the Contractor unless otherwise specified or indicated on drawings. Support and anchor design calculations shall be provided to the Architect or Engineer upon request.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 and NFPA 13.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS

- A. Shop Drawings: Submit, for approval, complete calculations and details for field fabricated support installations (trapeze hangers, metal framing systems, and equipment supports);

designed by a Registered Structural Engineer in the State in which the project is located.
Submittal shall include Engineer's Seal affixed thereto.

- B. Show fabrication and installation details and include calculations for the following; include Product Data for components.

1.06 GENERAL REQUIREMENTS

- A. Hangers, structural supports, and attachments shall include all labor, supplemental steel, or other smaterial necessary for support of pipe furnished by Contractor. Factory fabricated items shall be complete with nuts, bolts, washers, etc. Where type and size are not indicated, proper selection shall be determined by Contractor. Refer to Noise & Vibration Isolation section of this specification for special support and hanger requirements.
- B. Refer to architectural and structural drawings for type of structure. Do NOT hang/support any single point loads greater than 500 lbs. from steel beams/purlins; and NOT greater than 250 lbs. from concrete slab or steel bar joists; unless specifically noted otherwise on the structural drawings. Weights shall not exceed framing member allowance. Where this Contractor violates allowances, any and all resultant damage and costs to correct, as determined by the Architect/Engineer, will be borne by this Contractor.
- C. Supports include equipment anchoring to floor slab, brackets to wall, hangers to equipment supported from structure above, etc. Refer to drawings for equipment and locations.
- D. Supplemental steel spanning structural framing elements may be steel angles or channels specifically sized for equipment/pipe weight. Supports shall be sized with a minimum safety factor of 5 to 1, or as required by code; most stringent requirement shall apply. Contractor may provide supplemental supports as manufactured by Unistrut, B-Line systems, or approved equal.
- E. Hangers and supports shall conform to recommendations of Standard Practice No. 58 and 69 of Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS).
- F. All exterior supports, hangers, attachments, etc. shall be galvanized or stainless steel; including all accessories, fasteners, etc.

1.07 REFERENCES

- A. American Concrete Institute, ACI:
 - 1. ACI 301: Specifications for Structural Concrete for Buildings.
 - 2. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 3. ACI 347: Recommended Practice for Concrete Formwork.
- B. American Society of Testing and Materials, ASTM:
 - 1. ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement.
 - 2. ASTM A185: Welded Steel Wire Fabric For Concrete Reinforcement.
 - 3. ASTM C33: Concrete Aggregates.
 - 4. ASTM C150: Portland Cement.
 - 5. ASTM C171: Sheet Materials for Curing Concrete.
 - 6. ASTM C260: Air-Entraining Admixtures for Concrete.
 - 7. ASTM C309: Liquid Membrane Forming Compounds for Curing Concrete.

- 8. ASTM C404: Aggregates for Masonry Grout.
- C. American National Standards Institute, ANSI:
 - 1. ANSI/ASME B31.9: Building Services Piping.
- D. Concrete Reinforcing Steel Institute, CRSI:
 - 1. CRSI Manual of Standard Practice.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, MSS:
 - 1. MSS SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture.
 - 2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
- F. National Electrical Manufacturers Association, NEMA:
 - 1. NEMA ML 1: Metal Framing (Continuous Slot Metal Channel Systems).

1.08 REGULATORY REQUIREMENTS

- A. International Building Code and International Plumbing Code, 2012 version.
- B. NFPA 13.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hangers and Supports:
 - 1. Mason Industries: www.mason-industries.com.
 - 2. Nibco: www.nibco.com.
 - 3. PHD Mfg, Inc: www.phd-mfg.com.
 - 4. Bang-It
 - 5. Wood-Knocker
 - 6. Drop-In Anchors

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Single Pipe Support: Provide factory fabricated horizontal piping hangers, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69.
 - 1. Type: Adjustable Steel Clevis; Type 1
 - 2. Use only one type by one manufacturer for each type of piping service.
 - 3. Select hangers and supports sized to exactly fit pipe size for bare piping; and to exactly fit around pipe insulation with saddle and shield for insulated piping.
 - 4. Provide rubber or neoprene lined pipe ring isolators and copper plated hangers and supports for copper piping systems.
 - 5. Size in accordance with MSS and manufacturer's recommendations, most stringent shall apply; minimum safety factor of 5.
 - 6. Based on Anvil Fig. 260 for insulated pipe of any type, non-insulated ferrous alloy pipe and non-insulated plastic pipe; Anvil Fig CT-65 copper plated carbon steel light duty adjustable clevis hanger for non-insulated copper piping NPS 1/2 thru 4.

- B. Trapeze Pipe Supports: Allowed for parallel runs of piping.
 - 1. Shop- or Field-fabricated: Provide MSS SP-69, Type 59 pipe support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
 - 2. Factory-fabricated: Provide channel strut system, B-line B22 or heavier as required for load and/or span lengths. Provide steel blocking of varying thickness welded to channel under each sloped pipe as required to obtain proper pitch. Strut clamps, straps, and rollers shall be used to maintain proper alignment:
 - a. Clamps and straps: B-Line series B2000 or B2400.
 - b. Rollers: B-Line figures B218, B219, B379, B479 or B3126

2.03 ATTACHMENTS

- A. Hanger Rod Attachments: Provide factory fabricated hanger rod attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Select size of hanger rod attachments to suit hanger rods; size attachments to suit equipment/pipe hanger/rod and applied load.
 - 3. Proved copper plated hanger rod attachments for copper piping systems.
 - 4. Type: MSS Type 13 Steel Turnbuckles
- B. Building Attachments: Provide factory fabricated hanger rod and brace angle attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Size attachments to suit equipment/pipe hanger/rod size and applied load.
 - 3. C-Clamps: MSS Type 23.
 - 4. Steel Brackets:
 - a. MSS Type 31 for light duty.
 - b. MSS Type 32 for medium duty.
 - c. MSS Type 33 for heavy duty.

2.04 FIRE AND SMOKE PENETRATION SEALANT

- A. UL listed; flexible sealant or pre-fabricated metal device.

2.05 MISCELLANEOUS SUPPORT MATERIALS

- A. Metal Framing: NEMA Standard ML 1
- B. Structural Steel: ANSI/ASTM A 36, carbon-steel plates, shapes and bars; black and galvanized.
- C. Hanger Rods: Steel, threaded both ends, threaded one end, or continuously threaded.
- D. Cement Grout: Portland cement, ANSI/ASME C150, Type I or Type III, clean uniformly grades, natural sand, ANSI/ASTM C404, Size No. 2; mix ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water for placement and hydration, non-shrink, nonmetallic, suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

2.06 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.07 EQUIPMENT SUPPORTS

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

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments complete with inserts, bolts, rods, nuts, and washers in accordance with manufacturer's recommendations and as required to properly support piping from the building structure.
 - 1. Install hangers and supports to prevent sway, vibration, and sag.
 - 2. Support piping at drops to equipment to prevent stress at the equipment connections.
 - 3. Locate hanger within three feet of a direction change. Locate hangers within one foot of each horizontal elbow. Provide additional supports at each side of heavy valves and equipment. Valves NPS 3 and larger in horizontal piping shall be supported independently of the adjacent piping.
 - 4. Install hangers with minimum 1/2 inch clear space between finished covering and adjacent work.
 - 5. Use hangers with vertical adjustment range of 1-1/2 inch minimum suited for adjustment after piping is erected.
 - 6. Hanging of pipes from other trades (ie. Ductwork, conduits, ceiling suspension systems, medical equipment structural support systems, etc.) is not acceptable. Hanging and support of piping from other piping is not permitted, even of same trade.
 - 7. Adjust hangers and supports after insulation installation to provide uniform loading and to bring piping to proper levels and elevations.
 - 8. Use bracket type hangers fastened to walls to support piping running adjacent to walls and not supported from structure overhead.
 - 9. Perforated strap iron hangers and wire are not permitted for either temporary or permanent installation.
 - 10. Hangers and supports shall be securely fastened to structural members by beam clamps and clips, concrete inserts, anchors and all required accessories.
- B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- C. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.02 EQUIPMENT BASES AND SUPPORTS

- A. Concrete:
 - 1. Provide for major equipment reinforced concrete bases poured directly on structural floor slab 4 inches thick minimum, extended 4 inches minimum beyond machinery bedplates.
 - 2. Formwork: ACI 347.
 - a. Chamfer external corners of exposed concrete work.
 - b. Provide openings required by others as required.
 - c. Use manufacturer's templates or certified setting diagrams for placement of equipment anchor bolts and other mounting accessories.
 - d. Install accessories: Waterstops, expansion joints, and moisture barrier.
 - e. Reinforcement: CRSI, Manual of Standard Practice.
 - f. Concrete Placement: ACI 301, 304.
 - g. Concrete Curing : ACI 301.
 - h. Concrete Finishing:
 - 1) Horizontal Surfaces: Float and trowel to level, smooth, uniform, dense finish; leave struck off surface untroweled; or scratch struck off surfaces.
 - 2) Curbs: Strip form while concrete is green; steel trowel to hard dense finish with corners, intersections and terminations slightly rounded and coved.
 - i. Concrete Grouting: Grout openings and recesses as indicated, around mechanical work using grouting mix, tamped, screened, troweled and cured.
 - 1) See individual equipment Sections for specification for fine grouting (nonshrink grout) of equipment base plates on foundation bases.
 - j. Field Quality Control: Contractor engages testing laboratory to take on site slump or compression tests to ensure compliance with specifications.
- B. Install lateral bracing with pipe hangers and supports to prevent swaying.
- C. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- D. Trapeze Hangers:
 - 1. Where piping of various sizes are supported together by trapeze hangers, space hangers to accommodate maximum span permitted for smallest pipe; or install intermediate supports for smaller diameter pipe(s).
 - 2. Strut clamps, straps, and rollers shall be used to maintain proper alignment. Provide a clamp/strut/roller in each straight run of pipe every 30 feet on center.
- E. Pipe Movement: Install hangers and supports to allow controlled movement of piping systems
 - 1. Install hangers and supports to allow controlled movement of piping systems; to permit freedom of movement between piping anchors; and to facilitate action of expansion joints, expansion loops, expansion bends, and similar entities.
 - a. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement is not transmitted to connected equipment.

3.03 HANGER AND SUPPORT SPACING SCHEDULE

- A. Based on piping sizes and material types, install at maximum span distances, with minimum hanger rod sizes as follows, but not in excess of specified limits in NFPA 13. Specification based on individual piping supports and does not apply to trapeze systems:
 - 1. Horizontal Copper and Steel Piping:
 - a. NPS 1/2 to NPS 1-1/4: 6 feet maximum span, 3/8 inch diameter hanger rod.
 - b. NPS 1-1/2 to NPS 2: 10 feet maximum span, 3/8 inch diameter hanger rod.
 - c. NPS 2-1/2 to NPS 3: 10 feet maximum span, 1/2 inch diameter hanger.
 - d. NPS 4 to NPS 6: 10 feet maximum span, 5/8 inch diameter hanger rod.
 - e. NPS 8 to NPS 12: 10 feet maximum span, 7/8 inch diameter hanger.
 - f. NPS 14 and larger: 20 feet maximum span, 1 inch diameter hanger
 - 2. Hangers shall be placed adjacent either side of each piping joint and change in direction in addition to the above spacing criteria.

3.04 BUILDING ATTACHMENTS

- A. Space attachments within maximum piping spans indicated in MSS SP-69 and in spacing schedules this section. The most stringent, shortest distances shall apply.
- B. Install building attachments within concrete slabs or attach to structural steel.
- C. Concrete Structure Attachments:
 - 1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
 - 3. Structural attachments shall be approved box type inserts for concrete floors and roof decks.
 - a. Continuous inserts may be used for parallel lines of piping and equipment. Furnish spot or strip inserts with Styrofoam or cardboard filler strip to protect the cavity during pour and subsequent construction activities.
 - b. Anchor insert attachment to structure shall be installed in accordance with the manufacturer's recommendation for the application and approved by the Structural Engineer.
 - 4. Self-drilling concrete anchors, Phillips Red Head Series, and powder-actuated fasteners, Hilti Fastening Systems or approved equal may be used only with prior approval by the Architect and Structural Engineer. If approved:
 - a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer.
 - b. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 5. Inserts and anchors shall not be installed in concrete pan construction between joists.
- D. Steel Joist Attachments: Connect to top chord of all steel joists for all hangers from steel attached to joists.

- E. Install additional building attachments when supporting additional concentrated loads, including valves, flanges, and strainers NPS 2-1/2 and larger and at changes in piping direction, guides, and expansion joints.
- F. Anchors:
 - 1. Install anchors at locations preventing stresses from exceeding ANSI/ASME B31; and preventing transfer of loading and stresses to connected equipment.
 - a. Install anchors at ends of principal piping runs and at intermediate points in pipe runs between expansion loops and bends.
 - b. Preset anchors to accommodate both expansion and contraction of piping.
 - 2. Fabricate and install anchors by welding steel shapes, plates and bars to piping and to structure; in compliance with ANSI/ASME B31 and the American Welding Society (AWS).
 - 3. Anchors for Expansion Compensators: Install anchors in accordance with expansion unit manufacturer's recommendations.
 - a. Limit piping movement and forces to maximums recommended by manufacturer for each unit.

3.05 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.06 SLEEVES

- A. Setting: Set sleeves in advance of concrete work; provide reinforcing around sleeves.
- B. Wet Areas: Extend sleeves through potentially wet floors 2 inch above finished floor level.
 - 1. Caulk sleeves full depth and provide floor plate.
 - 2. Insulation: Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and construction with noncombustible mineral wool insulation.
 - a. Provide tight fitting metal caps on both sides and caulk.
 - 3. Install chrome plated escutcheons where piping passes through finished surfaces.
 - 4. When duct sleeves pass through fire and smoke barriers, pack void space between duct and sleeve with fireproof mineral wool.
 - a. Provide sheet metal duct flanges at wall to cover openings.

5. Prefabricated Wall Penetration Seals: Install and tighten seals in accordance with manufacturer's recommendations.
 - a. Ensure watertight pipe penetration.

3.07 FIRE AND SMOKE PENETRATION SEALANT

- A. Where supports pass through fire or smoke rated walls, partitions, floors, and ceilings, seal openings with UL rated materials.

3.08 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.09 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 9123 "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Exposed Steel Surfaces: Prime coat all exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.10 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Individual Hangers and Supports: Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
 2. Trapeze support system (MSS Type 59) with piping clamps or U-bolts (MSS Type 24) for support of pipes NPS 1/2 to NPS 30.
 3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 with vertical adjustment capability, steel-pipe base stanchion support and cast-iron floor flange.
 4. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 from two rods where longitudinal movement caused by expansion or contraction occurs.
 5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod where horizontal movement caused by piping expansion or contraction occurs.
 6. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 where horizontal movement caused by piping expansion and contraction occurs and with vertical and lateral adjustment capability during installation.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps or if additional intermediate supports between floors utilizing eyelets and additional hanger rod are required.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 4. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb.

- c. Heavy (MSS Type 33): 3000 lb.
- L. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 0529

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SECTION 21 0548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION PIPING
AND EQUIPMENT

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SECTION 21 0548 - VIBRATION AND SEISMIC CONTROL FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes
 - 1. Seismic restraints.
- B. Related requirements:
 - 1. Section 22 0516 - Expansion Fittings and Loops for Plumbing Systems

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Seismic Design Category: D. Refer to Structural Drawings for additional seismic design parameters.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV
 - 3. Component Importance Factor: 1.5 for all Fire Suppression systems, piping, and equipment.

1.04 SUBMITTALS

- A. Product Data: Provide schedule of vibration isolator type with location and load on each. Include spring constant, spring horizontal to vertical stiffness, maximum load capacity, color codes, neoprene durometer.
- B. Shop Drawings: Indicate seismic control measures.
- C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.
- D. Delegated Design Submittal:
 - 1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - 3. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors,

4. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 5. Coordination Drawings; Show coordination of seismic bracing for fire suppression piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Welding certificates.
- F. Qualification Data: For professional engineer and testing agency

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An Independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910, 7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Vibration Mountings and Controls - Amber Booth
- B. Kinetics Noise Control, Inc
- C. Mason Industries

2.02 SUPPLEMENTAL STEEL BASES

- A. Single Steel I-beams
 1. Dimensions: Beams shall have a minimum section depth of 8% of the longest span between vibration isolator supports; down to a minimum of 6"; of size and shape required for the equipment to be supported.
 2. Loading: Structural steel base shall provide a rigid, distortion free, mounting base for supported equipment, which allows no excessive differential motion between the equipment and structural steel base.

3. Anchoring: Provide prelocated and drilled anchor bolt holes into all structural steel bases to bolt down equipment.

B. Steel Frames for Fans

1. Steel base depth: Frames shall be steel beams or channels with a minimum depth of 8% of the longest span between isolators; minimum of 6" depth, maximum of 12" depth.
2. Dimensions: Sized to prevent distortion and misalignment of the drive mechanism, and to limit beam deflection on the drive side of .05 inches at starting torque.
3. Frame: Structure steel members and motor slide rail with holes predrilled to align with the fan and motor.
4. Height Saving Brackets: Shall be welded to the structural steel base or shall be formed as an integral part of the frame. Provide the lowest possible mounting heights with a minimum 1/2" base clearance.

2.03 SEISMIC RESTRAINTS

A. Seismic Snubbers:

1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding all combined static and dynamic forces, both direct and response amplified during a seismic event.

B. Seismic Cable Brace

1. Seismic Restraint: In the installed condition the restraint system shall be structurally capable of withstanding all combined static and dynamic forces, both direct and response amplified, during a seismic event. Restraint shall take place in all suspended modes and limit travel by a 1/8 - 1/4 inch slack in the aircraft cable. Equipment shall be bolted to building structure to resist all applicable seismic forces.
2. Installation: Cable braces shall be utilized for suspended piping and mechanical equipment in conjunction with spring hangers or suspended ductwork or piping. Cables shall be installed at 45 degree or alternate angles to suspend equipment. Motion shall be restricted in two horizontal directions and in the downward vertical direction.
3. Submittals: Shall provide all seismic load calculations and drawings demonstrating compliance with the governing criteria. If limited access prevents installation at 45 degrees, seismic calculations shall be submitted to demonstrate compliance with alternate angles.

C. Seismic Rod Clamp

1. Seismic Restraint: Hanger rod steel angle and locking bolts used in conjunction with spring hangers or suspended ductwork or piping. In the installed condition the reinforcement system shall be structurally capable of withstanding all combined static and dynamic buckling forces, both direct and response amplified, during a seismic event.
2. Installation: Shall be in accordance with manufacturers' seismic load calculations, and rod clamp spacing based on rod diameter with a minimum of 3 clamps per rod.
3. Submittals: Shall include all seismic load calculations and drawings demonstrating compliance with the governing criteria.

D. Neoprene Washer-Bushing

1. Applications: For seismic relief at spring or neoprene isolator baseplate bolt holes.
2. Submit: Durometer according to ASTM D676; tensile strength and percent elongation at break according to ASTM D412; over aging hardness, tensile strength and elongation at break according to ASTM D573; and compression set according to ASTM D395.

E. General Requirements for Restraint Components

1. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
2. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
3. Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
4. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
5. Resilient Isolation Washers and Bushings: Oil-and water-resistant neoprene.
6. Maximum 1/4-inch air gap, minimum 1/4-inch thick resilient cushion.
7. Channel Support System: MFMA-3, shop- or field fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
8. Restraint Cables: A3TM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and belts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
9. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
10. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
11. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
12. Resilient isolation Washers and Bushings: One-piece, molded, Oil-and water-resistant neoprene, with a flat washer face.
13. Mechanical Anchor Bolts: Drilled in and stud-wedged or female-wedged type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488, Minimum length of eight times diameter.
14. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installation and Quality Control: Except as otherwise indicated, the contractor shall comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading. Remove space blocks and similar devices intended for temporary protection against overloading during installation. Anchor and attach units to structural supports and equipment as required. Adjust leveling devices as required where leveling uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Where equipment base frames are specified, install base frames on isolator units so that a minimum of 1/2" clearance below the base will result when the supported equipment has been installed and loaded for operation. (2" clearance for inertia bases). The contractor shall adjust all vibration isolators after the system has achieved full operating weight so that: no vibration isolation element is short circuited; no undue stress is applied to the equipment, connected piping or structure; and no noise is transmitted to any support structure, connected surface or adjacent environment. After equipment installation and operation, it shall be the contractors' responsibility to demonstrate that the isolation system meets all of the criteria specified in this Section and on the Drawings, and has been properly installed.
2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
3. Where fan/duct flexible duct connectors are used, provide pairs of horizontal thrust restraint springs on centrifugal fans with more than 6.0 inches WC total static pressure, and on hanger supported, horizontally mounted axial fans with more than 3.0" W.C. total static pressure.
4. Provide isolated or integral seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 1/8 inch maximum clearance.
5. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for the first three points of support.

3.02 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. General

1. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
2. Seismically restrain all fire suppression and standpipe systems in accordance with NFPA 13 and NFPA 14.
3. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.

B. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors. Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. Housed spring mounts that accommodate both vibration and seismic requirements shall be submitted for review prior in acceptance.
- B. The fire suppression systems shall be seismically restrained in its entirety in accordance with the requirements of NFPA 13 and ASCE 07.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 21 Section piping sections for piping flexible connections.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency; Engage a qualified testing agency to perform tests and inspections.
- B. Tests and inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
- C. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
- D. Test to 90 percent of rated proof load of device.
- E. Measure isolator restraint clearance.
- F. Measure isolator deflection.
- G. Verify snubber minimum clearances.

END OF SECTION 210548

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SECTION 21 1313 - WET-PIPE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Cover system for sprinkler piping.
 - 3. Specialty valves.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.
- B. Related Requirements:
 - 1. Section 210529 - Hangers and Supports for Fire Suppression.
 - 2. Section 210548 - Vibration and Seismic Control for Fire Suppression
 - 3. Section 211119 - Fire-Department Connections

1.03 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler system shall be coordinated with other trades. See Section 210010 - Fire Suppression General Provisions for requirements.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- F. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.09 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's written permission.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
 1. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Refer to drawings for occupancy classifications.
 2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
 - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
 - f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
 3. Maximum Protection Area per Sprinkler: According to UL listing.
 4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 120 sq. ft. 225 sq. ft. Insert dimension.
 - b. Storage Areas: 130 sq. ft..
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7. See Section 210548 - Vibration and Seismic Control for Fire Suppression

2.02 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized- Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized- Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel. Pipe ends may be factory or field formed to match

joining method. Schedule 30 pipe shall be have the interior of the piping coated with anti-microbial coating.

- C. Schedule 40, Galvanized- Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel. Pipe ends may be factory or field formed to match joining method. Schedule 40 pipe shall be have the interior of the piping coated with anti-microbial coating.
- D. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 12, plain end.
- E. Galvanized and Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- F. Galvanized and Uncoated Steel Couplings: ASTM A 865/A 865M, threaded.
- G. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- H. Malleable- or Ductile-Iron Unions: UL 860.
- I. Cast-Iron Flanges: ASME 16.1, Class 125.
- J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: [AWWA C110, rubber, flat face, 1/8 inch thick] [ASME B16.21, nonmetallic and asbestos free] [or] [EPDM rubber gasket].
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- K. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- L. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Anvil International; a subsidiary of Mueller Water Products, Inc
 - b. Corcoran Piping Systems Co
 - c. National Fittings, Inc
 - d. Shurjoint Piping Products
 - e. Tyco Fire Suppression & Building Products
 - f. Victaulic Company
 - 2. Pressure Rating: 175-psig
 - 3. Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L ASTM B 88, Type M water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.04 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc. (The)
 - c. Tyco Fire Suppression & Building Products
 - d. Venus Fire Protection Ltd
 - e. Victaulic Company
 - f. Viking Corporation
 - g. Insert manufacturer's name.
 - 2. Standard: UL 193.
 - 3. Design: For horizontal or vertical installation.
 - 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages,[retarding chamber,] and fill-line attachment with strainer.
 - 5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 - 6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application
- G. Automatic (Ball Drip) Drain Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The) .

- b. Tyco Fire Suppression & Building Products .
- c. Insert manufacturer's name.
- 2. Standard: UL 1726.
- 3. Pressure Rating: 175-psig minimum.
- 4. Type: Automatic draining, ball check.
- 5. Size: NPS 3/4.
- 6. End Connections: Threaded.

2.05 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Anvil International; a subsidiary of Mueller Water Products, Inc
 - b. National Fittings, Inc
 - c. Shurjoint Piping Products
 - d. Tyco Fire Suppression & Building Products
 - e. Victaulic Company
 - f. Insert manufacturer's name.
- 2. Standard: UL 213.
- 3. Pressure Rating: 175-psig Minimum.
- 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
- 5. Type: Mechanical-tee and -cross fittings.
- 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
- 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
- 8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc
 - b. Reliable Automatic Sprinkler Co., Inc. (The)
 - c. Tyco Fire Suppression & Building Products
 - d. Victaulic Company
 - e. Insert manufacturer's name.
- 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- 3. Pressure Rating: 175-psig Minimum.
- 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
- 5. Size: Same as connected piping.
- 6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc
 - b. Fire-End & Croker Corporation

- c. Potter Roemer
 - d. Insert manufacturer's name.
 - 2. Standard: UL 199.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Brass.
 - 5. Size: Same as connected piping.
 - 6. Inlet: Threaded.
 - 7. Drain Outlet: Threaded and capped.
 - 8. Branch Outlet: Threaded, for sprinkler.
- D. Sprinkler Inspector's Test Fittings:
- 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. AGF Manufacturing Inc .
 - b. Triple R Specialty .
 - c. Tyco Fire Suppression & Building Products
 - d. Victaulic Company
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 3. Pressure Rating: 175-psig Minimum.
 - 4. Body Material: Cast- or ductile-iron housing with sight glass.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aegis Technologies Inc
 - b. CECA LLC
 - c. Corcoran Piping Systems Co
 - d. Merit; a brand of Anvil International
 - e. Insert manufacturer's name.
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 250-psig minimum.
 - 4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 5. Size: Same as connected piping.
 - 6. Length: Adjustable.
 - 7. Inlet and Outlet: Threaded.
- F. Flexible Sprinkler Hose Fittings:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc
 - b. FlexHead Industries, Inc
 - c. Gateway Tubing, Inc
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 175-psig Minimum.
 - 4. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

5. Size: Same as connected piping, for sprinkler.

2.06 SPRINKLERS - NON-LIGATURE RESISTANT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Globe Fire Sprinkler Corporation
 2. Reliable Automatic Sprinkler Co., Inc. (The)
 3. Tyco Fire Suppression & Building Products
 4. Venus Fire Protection Ltd
 5. Victaulic Company
 6. Viking Corporation
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
 1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Residential Applications: UL 1626
 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
 1. Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 2. Nominal Orifice: 17/32 inch with discharge coefficient K between 7.4 and 8.2.
- F. Sprinkler Finishes: Chrome Plated , Painted, or Bronze. Architect to select finish.
- G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Chrome-plated steel, one piece, flat Chrome-plated steel, two piece, with 1-inch vertical adjustment Plastic, white finish, one piece, flat.
 2. Sidewall Mounting: Chrome-plated steel Plastic, white finish, one piece, flat.
- H. Sprinkler Guards:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The)
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Company
 - d. Viking Corporation
 2. Standard: UL 199.
 3. Type: Wire cage with fastening device for attaching to sprinkler.

2.07 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Globe Fire Sprinkler Corporation
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Company
 - d. Viking Corporation
 - 2. Standard: UL 753.
 - 3. Type: Mechanically operated, with Pelton wheel.
 - 4. Alarm Gong: Cast aluminum with red-enamel factory finish.
 - 5. Size: 8-1/2-inches diameter.
 - 6. Components: Shaft length, bearings, and sleeve to suit wall construction.
 - 7. Inlet: NPS 3/4.
 - 8. Outlet: NPS 1 drain connection.
- C. Water-Flow Indicators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ADT Security Services, Inc
 - b. McDonnell & Miller; a brand of ITT Corporation <
 - c. Potter Electric Signal Company, LLC
 - d. System Sensor; a Honeywell company
 - e. Viking Corporation
 - f. Watts; a Watts Water Technologies company
 - g. Insert manufacturer's name.
 - 2. Standard: UL 346.
 - 3. Water-Flow Detector: Electrically supervised.
 - 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 5. Type: Paddle operated.
 - 6. Pressure Rating: 250 psig.
 - 7. Design Installation: Horizontal or vertical.
- D. Pressure Switches:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Barksdale, Inc
 - b. Detroit Switch, Inc
 - c. Potter Electric Signal Company, LLC
 - d. System Sensor; a Honeywell company
 - e. Tyco Fire Suppression & Building Products
 - f. United Electric Controls Co
 - g. Viking Corporation

- h. Insert manufacturer's name.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised water-flow switch with retard feature.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.
 - 5. Design Operation: Rising pressure signals water flow.
- E. Valve Supervisory Switches:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell International company
 - b. Kennedy Valve Company; a division of McWane, Inc
 - c. Potter Electric Signal Company, LLC
 - d. System Sensor; a Honeywell company
 - e. Insert manufacturer's name.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.
 - 5. Design: Signals that controlled valve is in other than fully open position.
 - 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

2.08 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AGF Manufacturing Inc
 - 2. AMETEK Inc.; U.S. Gauge Division
 - 3. Ashcroft, Inc
 - 4. Brecco Distribution Corporation
 - 5. WIKA Instrument Corporation
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 21 1100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.04 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- N. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices air compressors.
- O. Fill sprinkler system piping with water.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.05 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.06 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
1. Install valves in vertical position for proper direction of flow, in main supply to system.
 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.07 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.08 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints. Interior of piping shall be coated with anti-microbial coating.
 2. Type L Type M, hard copper tube with plain ends; cast- wrought-copper, solder-joint fittings; and brazed joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 5, shall be the following:
1. Standard-weight Schedule 40, black-steel pipe with roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 6, shall be one of he following:
1. Standard-weight Schedule 40, black-steel pipe with roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 3. Schedule 10 / NFPA 13-specified wall thickness black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 8 and larger, shall be the following:
1. Standard-weight Schedule 30, black-steel pipe with roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Standard-weight Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 3. Schedule 10 / NFPA 13-specified wall thickness black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers
 2. Rooms with Suspended Ceilings Concealed sprinklers, recessed, flush, and concealed sprinklers as indicated.
 3. Wall Mounting: Sidewall sprinklers.
 4. Spaces Subject to Freezing: Upright sprinklers Pendent, dry sprinklers Sidewall, dry sprinklers Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated Insert type.
 5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated Insert type.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright Pendent Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 22 0010 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Consult them for further instructions and be governed by the requirements thereunder.
- B. Related Work is specified elsewhere in Divisions 21, 23, 25, 26, 27, and 28, and when issued by the Owner, is hereby incorporated.

1.02 SUMMARY

- A. Work Included
 - 1. Furnish all labor, materials, equipment and related items, and perform all operations required to complete work within the intent of the Drawings and Specifications, whether or not specifically mentioned, and to deliver complete and fully operational plumbing systems subject to the conditions of the Contract. For this reason, the Contractor shall visit the premises and site before submitting their bid and familiarize themselves with the areas in which work is to be done.
 - 2. Provide plumbing and electrical details not mentioned or shown which are necessary for the successful operation of all systems. Clean, sterilize, flush and fill all systems per requirements to make them operational; including labor and materials for final fill of water, refrigerant, oils, grease, gases, antifreeze and brine.
 - 3. Set all sleeves and cut and patch all miscellaneous holes necessary for the convenient, orderly and proper installation of the work. Required holes through masonry and concrete construction with an area less than thirty five (35) square inches (20 inch diameter and less) shall be considered miscellaneous holes.
 - 4. Any work installed without regard to the work of other crafts which must, in the opinion of the Owner or Architect/Engineer, be moved to permit the installation of other work, shall be moved and replaced as a part of this work at no additional charge.
 - 5. Rough-in for and connect, as shown on the drawings, all equipment furnished by the
 - 6. Prove satisfactory operation of all equipment and controls to the Owner, Architect, and/or Engineer upon request.
- B. Work Not Included
 - 1. Certain labor and materials may be furnished and/or installed under other divisions of these specifications. Coordinate with other trades and arrange the work to make the parts fit together. The following items are to be accomplished under other divisions of these specifications.
 - a. Temporary Heat: See "Temporary Heat" Paragraph in this Specification Section and Division 01.
 - b. Roof Curbs: See "Roof Curbs" Paragraph in this Specification Section.
 - c. Concrete: See "Concrete" Paragraph in this Specification Section.

- d. Electrical Equipment and Wiring: See "Electrical Equipment and Wiring for Mechanical Division" Paragraph in this Specification Section.
 - e. Temporary Water and Toilet: See Division 01.
- C. Equipment Furnished by Owner
- 1. The Owner will award contracts, which will commence concurrently with this contract. Specifically this work will include:
 - a. Equipment Installation: Refer to appropriate drawings for equipment furnished by the Owner.
 - b. Rough-in service pipes to locations as required by architectural and mechanical drawings and equipment shop drawings. Provide service valves on all pipes except waste and vent pipes, plug or cap these. Final connections to equipment shall be made by Contractor.

1.03 QUALITY ASSURANCE

- A. Qualifications of Contractor: All materials and equipment shall be new and all work shall be executed with the maximum speed consistent with current accepted trade practices. Furnish materials and equipment promptly after authorization to proceed, and proceed with work in progress with the other contractors on the project. Perform all work included in the contract in a manner that will not cause interferences or delays to, or interfere with, the progress of other contractors.
- B. At all times when work is not in progress, keep all open ends of pipe, fittings, equipment and fixtures securely closed and protected.
- C. All welding shall comply with the requirements and recommendations of the American Welding Society and all applicable codes.
 - 1. Weld metal shall not project creating an obstruction.
 - 2. Chip or grind out all weld metal before re-welding.
 - 3. Caulking / preening of welds is not allowed.
 - 4. Welder shall be certified to work on service/utility type indicated.

1.04 CODES AND REFERENCED STANDARDS

- A. Comply with specified Codes and Standards. If conflict exists between Codes or Standards and drawings, project specifications manual or addenda requirements, the most stringent requirement shall apply.
- B. Conform to the installation rules and regulations of the standards listed including all subsequently published amendments thereto issued prior to the date of the bidding documents.
- C. Conform to the requirements of all local, state and federal agencies which have authority over the project. Include all items of labor and material required to meet such requirements regardless of the failure to specify in the project manual or indicated on the drawings each individual item.
- D. All equipment, apparatus and systems shall be rated, tested, fabricated and installed with the applicable industry standards.

- E. The applicable portions of the following standards form a part of this project manual to the same force and effect as if repeated herein.
 - 1. American National Standards Institute (ANSI)
 - 2. International Plumbing Code (IPC)
 - 3. American National Standards Institute (ANSI)
 - 4. American Gas Association, Inc. (AGA)
 - 5. American Society for Testing Materials (ASTM)
 - 6. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
 - 7. American Society of Mechanical Engineers (ASME)
 - 8. American Water Works Association (AWWA)
 - 9. National Electrical Code (NEC)
 - 10. National Electric Manufacturers Association (NEMA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 13. Underwriters Laboratories, Inc. (UL)
 - 14. Environmental Protection Agency (EPA)
 - F. Conform to the International Building Code and International Plumbing Code, 2006 edition.
 - G. Conform to applicable sections of NFPA 13 and NFPA 24.
 - H. Conform to the National Electrical Code, 2023 Edition.
 - I. Conform to the requirements of the Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) Standard 117.
 - J. Conform to Colorado Department of Public Health and Environment, Health Facilities and Emergency Medical Services Division, "Standards for Hospitals and Health Facilities".
 - K. Conform to requirements of the Facility Guidelines Institute (FGI) "Guidelines for Design and Construction of Healthcare Facilities", 2010 Edition. and the Joint Commission for Accreditation of Healthcare Organizations (JCAHO).
 - L. All work shall be furnished and installed in complete accordance with Code seismic requirements.
 - M. In case of difference between these specifications, codes, laws, industry standards, and/or utility company regulations the most stringent requirement shall govern.
- 1.05 EXAMINATION OF BIDDING DOCUMENTS
- A. Each bidder shall examine the bidding documents carefully, and not later than quantity of business days as specified in Division 01 prior to the date of receipt of bids, shall make written request to the Architect for interpretation or correction of any discrepancies, ambiguity, inconsistency, or error therein which he may discover. Any interpretation or correction will be issued as an addendum by the Architect. Only a written interpretation or correction by addendum shall be binding. No bidder shall rely upon interpretations or corrections given by any other method. If discrepancies, ambiguity, inconsistency, or error are not covered by addendum or written directive, Contractor shall include in their bid, labor materials and methods of construction resulting in higher cost. After award of contract, no allowance or extra

compensation will be made on behalf of the Contractor due to his failure to make the written requests as described above.

- B. In order to become familiar with the scope of the work involved, visit the existing site, before submitting bid, and carefully examine the existing conditions in order to have full knowledge and understanding of the conditions and restrictions affecting the performance of the work required. Include in bid all work which is reasonably inferred by the contract drawings and specifications, whether specifically shown or not, as a result of existing conditions, construction, irregularities and interferences which may affect work and is necessary for fully functioning system. No additional compensations will be considered for misunderstanding the conditions to be met.
- C. The person submitting the request will be responsible for its prompt delivery. Failure to so request clarification of any inadequacy, omission, or conflict will not relieve the Contractor of responsibility. The signing of the Contract will be considered as implicitly denoting that the Contractor has a thorough comprehension of full intent and scope of the working drawings and specifications.

1.06 BIDS AND SUBSTITUTIONS

- A. Materials, equipment or services listed by several identifying names are intended to be bidder's choice, and any of the listed names may be bid without soliciting prior acceptance. In all cases where more than one name is given in the specifications, the first named manufacturer's material, equipment or services shall be the basis of design which has been contemplated in coordination and production of the Contract Documents. Where equipment is noted in the drawings or on schedules in the drawings, the manufacturer and model number listed in the schedule shall be considered the basis of design and shall supercede listing order in the specification. Any changes, including spatial requirements, and costs required to accommodate materials or equipment other than the basis of design shall be the responsibility of the Contractor bidding other than basis of design equipment.
- B. If the Contractor wishes to submit a substitute to the named manufacturer(s) for any equipment, they shall submit in writing on Architect's Substitution Request form, prior to bid, stating the manufacturer's name, model number, and detailed product data. In all cases, if the substitute manufacturer is used, the Contractor shall bear all additional costs including, but not limited to, responsibility of coordination with all other trades, any changes incurred in plumbing, electrical, mechanical, general, etc., which result from equipment or material substitution.
- C. Where materials or equipment are specified by name, the proposed material or equipment must be identical to the specified material or equipment in all characteristics of quality, function and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture. Work performed or constructed with unapproved materials/equipment is at Contractor's risk, and any required correction of Work incorporating materials/equipment shall be at Contractor's sole cost and expense.
- D. Performance Specification of Products:
 - 1. Where any product is specified only by requirement to meet an industry standard or regulating body standard such as UL, AGA, AWWA, ANSI, etc. and the item proposed carries approval of that body, no prior acceptance by the Architect / Engineer is needed.

2. When any product or service is specified by requirement to meet a performance standard or is specified by a generic specification, (no manufacturers name listed) no prior acceptance by the Architect / Engineer is needed except as specifically called for in these specifications.
 - E. Approval by the Architect / Engineer of equipment other than the specified does not relieve Contractor of this Responsibility.
 - F. Acceptance
 1. In all instances, Contractor shall assume full responsibility for proof of equality of the stature to the equipment hereinafter specified. All data and information necessary for proof of equality, function and space requirements shall be prepared and accompany the submittal of the Substitution Request to the Architect / Engineer.
 2. Specified material and equipment shall be considered the basis of design, and while not specifically mentioned, characteristics such as material types, gauges, weights, appearance and space requirements of the basis of design materials and equipment must be met by any proposed substitutions.
 3. Action for substitutions specified herein will be given only after the receipt of formal Substitution Request accompanied by complete data showing performance over entire range, physical dimensions and material construction all specifically marked for the individual item in accordance with requirements for Submittals of Product Data.
 4. Where the substitution requires any changes in piping, electrical wiring, clear space for service requirement, venting, ducting, submit Coordination Drawings with the Substitution Request indicating changes required and conclusively coordinating changes required for the Plumbing Division as well as changes required for all other Divisions. Contractor submitting the Substitution Request shall:
 - a. Be responsible to coordinate all Divisions and make all changes required to accommodate the Substitution.
 - b. Pay for all changes required of both the Plumbing Division and all other Divisions to accommodate the Substitution.
 5. Approval of the Substitution Request by the Architect / Engineer does not relieve the Contractor of the above responsibilities. See General Conditions for method of notification of acceptance.
 - G. In the event the substituted material or equipment does not perform to meet the design intent, fit or meet quality standards, the Contractor shall provide the specified material or equipment and bear all costs to replace the substitute item(s).
- 1.07 BID ALTERNATE(S)
- A. Refer to Division 01 for items requiring alternate pricing within the contract documents.
 - B. Alternate(s) for Materials and Equipment
 1. Equipment and material bid alternate(s) shall be proposed as additive or deductive alternate(s) to specified items by submitting it as a separate line item from the base bid on the Bidder's letterhead.
 2. Such bid alternate proposals shall not be substituted or included in the base bid. Bid alternate proposal(s) must be accompanied by full descriptive data on the proposed equipment, together with a statement of the cost to be added or deducted for each item.

The bid alternate shall include all materials, equipment, labor, electrical connections, coordination with all other trades, etc. for a complete and operational system.

3. The Contractor shall submit the bid alternates at the time the base bids are due.

1.08 PERMITS, FEES AND NOTICES

- A. Apply for and pay for all permits, fees, licenses and inspections for this Division of work.
 1. Do not include the cost of any "Plant Investment Fee" or "System Development Charge" for sewer and/or water charged by the City. This will be arranged for and paid for by the Owner.
 2. Do not include the cost of any "Gas Application Fee" charged by the Utility Company. This will be arranged and paid for by the Owner.
- B. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.

1.09 PLANS AND SPECIFICATIONS

- A. The intention of the plans and specifications is to provide all piping, fixtures, and equipment. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Wherever the term "provide" is used, it shall mean "furnish and install".
- B. All plans and specifications including architectural, interiors, site, structural, electrical, plumbing fire protection, and HVAC plans shall be examined by Contractor prior to submission of quotations to determine systems interface and conditions which could cause interference or deviations in equipment locations and routing. Errors or discrepancies on plans or in specifications shall be reported to the Architect/Engineer in writing and written instructions obtained for the discrepancy prior to submittal of bid to the Owner.
- C. All changes from the plans necessary to make the work conform to buildings as constructed and to fit work of other trades, or to conform to rules of all governing authorities and regulations, shall be met by each Contractor without extra cost to the Owner.
- D. Routing of piping and location of equipment and other devices are shown on plans in a diagrammatic manner for general guidance. Plans shall not be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings, and from the structure itself before fabricating any work. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect, or Engineer.
- E. Manufacturer's drawings and instructions shall be followed in all cases where the makers of devices and equipment furnish directions covering point not shown on the drawings or described in the specifications. Install all equipment in accordance with manufacturer's recommendations, unless approval is given in writing by the Engineer for deviation.
- F. Layout and installation of plumbing work shall be coordinated with the overall construction schedule of various trades to prevent delay in completion of the project. Complete drawings and specifications for the entire job shall be maintained and updated at the job site. Coordinate

the plumbing work with and be responsible to the General Contractor for satisfactory progress of the work. Coordinate plumbing work with all other trades on the project without additional cost to the Owner.

- G. Priority of interpretation of discrepancies in Contract Documents shall be complimentary from specifications to drawings. Where discrepancies occur between various specifications, drawings and specifications or codes and standards, the most demanding requirement shall take precedence, except where written interpretation from the Architect/Engineer indicates otherwise.
- H. All work and materials covered by drawings and specifications shall be subject to review at any time by representatives of the Architect and Owner. If the Architect or Owner's agent finds any materials or installation that does not conform to these drawings and specifications, Contractor shall remove the material from the premises and correct the installation to the satisfaction of the agent.
- I. In acceptance or rejection of installed mechanical systems, no allowance will be made for lack of skill on the part of the installers.

1.10 SUBMITTALS

A. General

- 1. Submit under provisions of Division 01 and the requirements below.
- 2. The purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect / Engineer that the Contractor understands the design concept. Contract shall demonstrate their understanding by indicating which equipment and material they intend to furnish and install, and shall detail the fabrication and installation methods they intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and contract documents are discovered either prior to or after shop drawings and specifications shall control and shall be followed.
- 3. Review of Submittals is rendered as a service only and shall not be considered as a guarantee of measurements or of building conditions; nor shall it be construed as relieving the Contractor of basic responsibilities under their Contract. Architect / Engineer will check submittals only for conformance with the design concept of the project. Review shall not be construed as:
 - a. Permitting any departure from the contract requirements.
 - b. Relieving the Contractor of the responsibility for any error in details, dimensions or otherwise that may exist in the Shop Drawings.
 - c. Contractor agrees that shop drawing submittals processed by the Architect / Engineer are not change orders.
- 4. Submittal Schedule: Generate a Schedule of anticipated initial submittals for this Division and provide to General Contractor. Include in schedule specified durations time for review, submittal revision, resubmittal, and subsequent review as indicated in Division 01. Structure submittal schedule to allow for construction and delivery long lead and critical path items based on the overall project construction schedule. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet construction schedule, together with any special handling charges, shall be borne by the Contractor.

B. Shop Drawings

1. Proposed Product List: At the onset of Project's submittal phase, this Contractor shall submit a complete list of all material and equipment they propose to use in the installation. This list shall include all products specified in this Division and indicate manufacturer, catalog numbers and other identifying information. Architect / Engineer reserves the right to not review individual Product Data and Shop Drawing submittals until the Proposed Product List has been submitted and reviewed.
2. After review of the Proposed Product List by the Architect / Engineer, the Contractor shall submit Product Data and Shop Drawings including descriptive literature of the equipment to be provided under this contract. Drawings shall state capacities, sizes, etc., of all equipment and shall be certified.
3. The shop drawings shall be reviewed by the Contractor and stamped and signed certifying they have reviewed and found them to be 100% complete and accurate, prior to submission. Mark project name and location on each shop drawing, catalog cut and/or specification sheet along with Contractors signed stamp. Architect / Engineer reserves the right to reject shop drawings submitted without project name, location or stamp of Contractor's review.
4. Clearly mark each shop drawing, catalog cut and/or specification sheet to indicate those products and features which are intended to be furnished. Use highlights, arrows, underlines, circles and strikethroughs to identify exact features, options, capacities, characteristics and dimensions of equipment to be provided. Strike through information that does not apply to the intended product, options not intended to be included, and any manufacturer's disclaimers such as "Dimensions Subject to Change Without Notice." Options not specifically struck will be understood to be included. Architect / Engineer reserves the right to reject shop drawings not adequately marked in the above manner.
5. Review and approval of shop drawings shall not relieve the Contractor from the responsibility of furnishing equipment and materials of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents. Review and approval does not relieve the Contractor from responsibility for errors on the shop drawings. If the shop drawings deviate from the contract documents, Contractor shall advise the Architect / Engineer of such deviations in writing accompanying the shop drawings submittal, including the reasons for the deviations. Coordinate all required changes with the other trades affected. If the changes are occasioned by the Contractor, they shall pay any costs involved.

C. Coordination Drawings

1. This Contractor shall provide the support role in development of a combined set of coordination electronic drawing(s) to conclusively coordinate spatial arrangements of their materials and equipment with all other trades, and to define sequencing and coordination of installations for efficient flow of the Work. Coordination drawings shall be minimum scale of 1/4" = 1/0" along with a detailed 3-D model showing locations, dimensions and height of installation of all major pieces of equipment, ductwork and piping provided under their respective contracts. Drawings shall include the following:
 - a. Bottom of duct height and size
 - b. Piping elevations and size
 - c. Power and Data Conduit elevations and size
 - d. Hanger support locations (Ductwork / Piping / Conduit / Cable Tray)
 - e. Lighting devices
 - f. Telecom / Security

- g. Fire Protection mains/branch lines/head placement with elevations and size
 - h. Building structure background
 - i. Proposed locations for access panels (Ductwork/Piping/Conduit/Cable Tray)
 - j. Indicate the locations of all equipment and materials, including clearances required for servicing and maintaining equipment.
 - k. Indicate movement and positioning of large equipment into the building during construction.
2. Order of space preference throughout the building shall be:
- a. Recessed light fixtures
 - b. Ductwork
 - c. Soil, Waste, vent and storm piping
 - d. Domestic water piping
 - e. Sprinkler piping
 - f. Electrical conduit
 - g. Exception: Plumbing lines below or behind plumbing fixtures shall have precedence over all other work. Electrical conduit above or below switchgear, panel boards and control panels shall have precedence over all other work. Do not install any fluid conveying piping over electrical or elevator equipment
3. Prepare and submit the coordination drawings including detailed three dimensional model for review. By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.
4. The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittals has been approved by the Engineer.
5. Where Contractor has failed to provide proper space for equipment and required clearances (as required by local AHJ, as related to code requirements, as noted or shown on plans or as noted on submittals) Contractor shall relocate the equipment as directed by Engineer. Contractor shall be held responsible for any and all changes resulting from such relocations and shall be held responsible for any and all changes resulting from such relocations and shall bear any and all increase costs to Contractor as well as costs to other trades in making said revisions.

D. Architect / Engineer's Review of Submittals:

- 1. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect / Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect / Engineer in writing of such deviation at the time of submittal and the Architect / Engineer has given written approval of the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings Product Data, Samples or similar submittals by the Architect / Engineer's approval thereof.
- 2. Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

3. The Architect / Engineer will review and approve or take other appropriate action upon contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect / Engineer's action will be taken with such reasonable promptness as to cause no delay in the Work of the Contractor or in the activities of the other Contractors, the Owner, General Contractor, or the Owner's Representative, while allowing sufficient time in the Architect / Engineer's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation of performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect / Engineer's review of the Contractor's submittals shall not relieve the Contractor of the obligations per the Contract Documents.

1.11 EXISTING UTILITIES

- A. The plans indicate the location, type and sizes of various utilities within the site where known. These utilities are indicated as accurately as possible. If utilities are encountered during construction, which are not shown on the drawings, ask for instructions from the Architect. Any relocation or remodeling required will then be directed by change order. Assume all responsibility for protection of all utilities, shown or not, and repair any damage caused by this construction at no extra charge to the Owner.
- B. Investigate with proper authorities for all existing water taps, etc. and make arrangements to pay for all removal charges in original bid.
- C. Owners of all underground utilities shall be notified prior to excavation so that they can locate and mark underground utilities.

1.12 PLUMBING EQUIPMENT AND PIPING INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible, and in accordance with minimum required clearances as specified in codes and regulations.
- H. The word “concealed” as used in this specification refers to such spaces as pipe and duct chases, pipe and duct trenches, above plastered ceilings, in walls and buried where pipe and/or duct is inaccessible when building is complete. “Exposed” is intended to be within equipment rooms, unfinished areas, above “push up” ceilings, accessible pipe and duct tunnels.
- I. The term “furnish” means supply and deliver to Project, unless otherwise defined in greater detail. The term “install” is used to describe operations at Project, from inspecting and unloading, to completion in place, ready for intended use. The term “provide” means furnish and install, complete and ready for intended use, unless otherwise defined in greater detail.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Use only new materials, of the best quality of their respective kinds.
- B. All materials, in general, shall be Underwriter's Laboratories listed and labeled.

2.02 EQUIPMENT MANUFACTURER

- A. Equipment in the following categories shall be of one manufacturer or available through one manufacturer for each category to facilitate ease of maintenance for the Owner.
 - 1. Access Doors
 - 2. Motors (open drip-proof squirrel cage)
 - 3. Plumbing Fixture Trim
 - 4. Pressure Gauges
 - 5. Starters
 - 6. Strainers
 - 7. Temperature Controls
 - 8. Thermometers
 - 9. Valves

PART 3 - EXECUTION

3.01 ENGINEERING BY CONTRACTOR

- A. The construction of this building requires the contractor to design several systems or subsystems. All such design shall be the completed responsibility of the contractor. Hangers, supports and seismic restraint systems and design details are hereby delegated to the contractor to design, detail, and submit with seal of Registered Professional Engineer for review by Architect / Engineer.

3.02 SAFETY AND MAINTENANCE OF WORK AREAS

- A. The Engineer has no contractual responsibility in connection with job site safety measures or precautions as related to means, methods, techniques, sequences or procedures. Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Architect/Engineer's observations of the Contractor's performance are not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site. Contractor shall be responsible for providing all such safety measures and shall consult with the Local, State or Federal Safety Inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist; or whether he is or is not in compliance with Safety Regulations.
- B. During the project, this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project

3.03 HANDLING AND STORAGE OF MATERIALS AND EQUIPMENT

- A. Provide for proper storage of all materials and equipment and assume responsibility for losses due to any cause. All storage shall be within the contact limit lines of the building site. Cover and store all equipment and materials out of elements; any rusted or weather damaged item shall not be used.
- B. It is recognized that space at the project for storage of materials and products is limited. Coordinate the deliveries of plumbing[and medical gas] systems materials and products with the scheduling and sequencing of the work so that storage requirements at the project are minimized. In general, do not deliver individual items of equipment to the project substantially ahead of the time of installation. All materials shall be covered prior to installation and protected until final acceptance.

3.04 COORDINATION AND INSTALLATION OF THE WORK:

- A. COORDINATION AMONGST TRADES:
 - 1. This Contractor shall provide a qualified person during the construction phase of the shop drawing development that has the skills to convert the diagrammatic project drawings into composite assembly drawings in the CAD format determined by the Mechanical Contractor, for integration of systems into the combined master per floor coordination documents being assembled by the Mechanical Contractor. These coordination / fabrication drawings will conform to the performance criteria identified in the project documents and will fit into the 3 Dimensional allotted space for all systems. Where the piping dimensions, sizes and general arrangements of elements will require to be adjusted due to coordination of new or existing building structure, Architect's reflected ceiling plan and other trade's materials and or equipment space needs, qualified person will provide proposed recommendations of sizes, elevation changes, offsets, etc. for inclusion in a combined drawing(s) for the coordination meetings that will be reviewed by the Architect, Engineer, Owner and other trades to provide an overall acceptance of coordination per floor.
 - 2. The layout shown on the drawings is necessarily diagrammatic but shall be followed as closely as other work will permit. Changes from these drawings required to make this

work conform to the building construction shall be made only with prior written approval of the Architect/Engineer. All proposed changes shall be shown on shop drawings. All measurements shall be verified by actual observation and all work shall fit in place meeting the approval of the Architect/Engineer.

3. Provide openings required in new and existing construction that may be necessary. All patching and repairing shall be done by workmen competent in the trade required, at the expense of this Contractor. Arrange work so that minimum cutting will be required. All rubbish and excess materials involved in such cutting shall be promptly removed from the site and disposed of. Cutting through the floor or roof systems or load bearing walls shall be done only with the prior written approval of the Architect/Engineer so as to avoid damaging the structural system.

B. SEQUENCING, SCHEDULING:

1. Confer with the other contractors regarding the location and size of pipes, equipment, ducts, openings and special architectural treatments in order that there may be no interferences between the installation or the progress of the work of any contractor on the project.
2. In the case of interconnection of the work of two or more contractors, verify at the site or on shop drawings all dimensions relating to such work. All errors due to the failure to so verify any such dimensions shall be promptly rectified.
3. Access panels, in walls or ceilings, required (i.e., automatic or manual damper, fire or smoke damper, coil or control instrument mounted in a duct or pipe) shall be provided by the respective contractor and installed by workman competent in the trade required at the expense of this Contractor. Access panels are not required in areas where the ceiling system is lay-in tile; however, sufficient space must be available in and through the ceiling system to allow maintenance and adjustment of dampers, and cleaning of coils as necessary, or a suitable access panel shall be provided for that purpose. Access panels shall be approximately 24 inches by 24 inches wherever possible and shall be provided with flush trim and an allen-key operated camlock fastener. Submit manufacturer's product data to Architect for approval.
4. Items of equipment may be specified in the singular however, provide and install the number of items of equipment as required for a complete system.
5. Provide excavating, pumping, backfilling and compacting required, as shown on the drawings.
6. Equipment and devices which have factory prime coat or final surface finish shall be replaced, repaired or refinished if defective or damaged during installation.
7. Arrange all work so a minimum period of interruption or outages will occur in the temporary or permanent transfer of services as required for all electrical revisions. Not less than two (2) weeks notification to the Using Agency/Owner shall be required before approval will be granted for any disruption of services. The outage request shall include the extent of the work to be done, length of outage time required and the time at which the outage is to begin. No allowance will be made for extra payment as a result of scheduling "overtime" work necessary to perform before or after normal or regular working hours to accomplish the work intended.
8. Submit a "Sequence of Work Schedule" in respect to all temporary and permanent utility and service cutovers after final determination. This schedule shall be submitted for approval to the Architect/Engineer. The submittal shall designate priority order, service or utility affected, date of cutover, and time of day to start and finish.

C. MANUFACTURER'S INSTRUCTIONS

1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. All items which are a source of noise generation and/or mechanical vibration shall be installed with proper attenuation provisions including absorbers, isolators, or mufflers as required to prevent objectionable noises and vibrations.
4. If a conflict exists, notify the Architect/Engineer in writing and obtain instruction before proceeding with the work in question.

D. HOISTING AND MOVEMENT OF EQUIPMENT

1. This Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.
2. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
3. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.
4. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
5. Where mechanical products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

E. CONCRETE

1. All poured in place concrete required for equipment furnished under this Division shall be furnished & installed by this Division in accordance with requirements specified under the Architectural Divisions of these Specifications.
2. Concrete pads shall be minimum 4 inch high and anchored to the floor with dowels.

F. CLEARANCES

1. Install piping and equipment:
 - a. Straight and true.
 - b. Aligned with other work.
 - c. Close to walls and overhead structure (allowing for insulation).
 - d. Concealed, where possible, in occupied spaces.
 - e. Out-of-the-way with maximum passageway and headroom remaining in each space.
 - f. Conceal all piping in finished areas of the building except where otherwise noted on the drawings.
2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:
 - a. 7'0" headroom in storage spaces.
 - b. 8'6" headroom in other spaces.
3. Do not obstruct windows, doors or other openings.
4. Give the right-of way to piping systems required to slope for drainage (over other service lines and ductwork).
5. Offsets, transitions and changes in direction in pipes shall be made as required to maintain proper head room and pitch of sloping pipes whether or not indicated on the

drawings. Furnish and install all traps, air vents, sanitary vents, etc., as required to affect these offsets, transitions and changes in direction.

G. ACCESS AND ACCESS DOORS

1. Install all work to permit removal (without damage to other parts) of coils, heat exchanger bundles, boiler tubes, fan shafts and wheels, filters, belt guards, sheaves and drives, and all other parts which might require periodic replacement or maintenance. Arrange pipes and equipment to permit ready access to valves, traps, starters, motors, control components and to clear the openings of doors and of access panels. Furnish access panels for all mechanical equipment and valves requiring access in concealed locations for installation by contractor.
2. Provide shop drawings to the Architect and Engineer showing locations of all access panels.
3. Furnish access doors of type suitable to Architect and provide to General Contractor to construct into the building. Access doors should be provided in all locations where access is required.
4. Provide painted, steel (unless noted otherwise) access doors with key lock suitable for the surface in which they are installed and satisfactory to the Architect.
 - a. Plaster finish walls and ceilings: Recessed style.
 - b. Acoustical tile ceilings: Recessed type.
 - c. Drywall walls and ceilings: Flush panel.
 - d. Remodel Applications: Flanged flush panel.
 - e. Corrosive environments, including but not limited to, restrooms, locker rooms, pool equipment rooms, and natatoriums: Panel and frame shall be aluminum or stainless steel. All associated hardware and fasteners shall be stainless steel.
 - f. Panels in fire and/or smoke rated assemblies shall be listed for the application and carry the appropriate rating for the assembly in which they are installed.
 - g. High and Medium Risk patient locations: Security type.

3.05 SEISMIC ANCHORAGE AND BRACING

- A. All equipment and piping shall be braced, restrained, anchored or sway braced to resist a seismic event; as required by Chapter 16 of the 2006 International Building Code and ASCE 7-05. Refer to Structural Drawings for Design Spectral Response at Short Periods. Consider the building Occupancy as Category IV. Consider all piping, equipment, and systems installed under this Division as crucial for the continued operation of the facility after a seismic event and are thus assigned an $I_p = 1.5$ Importance Factor.
- B. Piping shall be installed per SMACNA, Seismic Restraint Manual, Guidelines for Mechanical Systems and Plumbing Piping Systems, and all code requirements. See Schedules and Details on Drawings.
- C. Contractor shall submit with equipment and piping shop drawings all required anchorage, bracing and restraints complete with calculations/details designed by a Registered Structural Engineer, and Engineers' Seal and Signature shall be affixed thereto.
 1. Contractor shall be responsible to obtain and provide all anchors, supports, etc. necessary for all code agency approvals.
 2. Piping may also be restrained by prefabricated supports; Midland Ross Corporation, Superstrut Universal seismic supports; Kin-Line Inc., seismic restraint system; B-Line

seismic restraints; TOLCO seismic restraints; or any other pre-approved system recognized by the city/county, state codes; provide proof of compliance.

3.06 PROTECTION OF WORK AND PROPERTY

- A. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work of Owner's operation.
- B. Close all pipe openings with caps or plugs during installation. Cover all fixtures and equipment and protect against injury. At the final completion, clean all work and deliver in an unblemished condition, or refinish and repaint at the discretion of the Architect.
- C. Any equipment, duct or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Architect / Engineer's satisfaction.
- D. Initial fill of traps: Provide initial water seal fill for all waste p-traps, condensate traps, or similar traps.

3.07 PROTECTION OF POTABLE WATER SYSTEMS

- A. All temporary water connections shall be made with an approved back flow preventer.
- B. All hose bibbs shall have, as a minimum, a vacuum breaker to prevent back flow.
- C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.08 TEMPORARY HEAT, VENTILATION, AND AIR-CONDITIONING

- A. Temporary heat, ventilation, and air-conditioning (HVAC), if required for the construction activities, shall be furnished by the General Contractor. Use of the permanent HVAC system shall not be allowed without written authorization from the Engineer. In the event the permanent HVAC systems are desired to be used prior to substantial completion and final cleaning, the General Contractor shall meet all requirements of the Engineer's written authorization and shall pay all utility costs for operation of the HVAC systems until acceptance by the Owner.

3.09 ELECTRICAL EQUIPMENT AND WIRING FOR PLUMBING DIVISION

- A. Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule. (PD is Plumbing Division - ED is Electrical Division).

3.10 Notes:

- A. If furnished as part of factory wired equipment, wiring and connections only by ED.
- B. If any of these devices carry the full load current to any motor or resistive element(s) they shall be connected by ED. Control devices carrying full load current furnished by PD and wired by

ED shall be located at the device being controlled, unless shown on drawings or mutual agreement is made between the contractors with no change in the contract price.

- C. Wiring from alarm contacts to alarm system by ED; all control function wiring by PD. Duct detectors furnished by ED, set in place by PD.

3.11 GENERAL NOTES:

- A. The above list does not attempt to include all components. All items necessary for a complete and operable system shall be included in the base bid.
- B. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connectors.

3.12 FLUSHING, CLEANING & STERILIZING

- A. Intent: It is the intent of this specification to require that all work, including the inside of equipment, be left in a clean condition with all dust, grease, and construction debris removed.
 - 1. Piping and connection equipment to be left free of sediments, core sand, grease, etc.
 - 2. Clean all exposed surfaces of piping, ducts and hangers, etc., sufficiently to receive paint. Vacuum ducts as required for debris removal.
 - 3. Air systems shall not be operated without filters. Replace the filters or clean permanent type filters just prior to substantial completion. All air systems shall be furnished with one additional set of filters for owner replacement.
 - 4. Remove and clean all screens, interceptors, strainers, etc., in piping systems just prior to substantial completion.
 - 5. Clean and wipe dry all plumbing fixtures, exposed valves, faucets, and piping, etc. that are exposed just prior to substantial completion. Clean all equipment and fixtures per manufacturer's specifications to avoid scratching finished surfaces. Leave all plumbing fixtures ready to use.
 - 6. 6.
 - 7. Thoroughly clean all equipment room floors after completion of equipment, pipe and duct cleaning. A condition of final acceptance will be the cleanliness of all exposed systems, equipment, and equipment rooms.
- B. Before final connections are made in the piping systems, blow out all piping with air and then wash out with cleaning compounds. Then flush the system to remove of all foreign materials. Furnish all temporary connections, valves, etc, required for this purpose. Clean the boiler and chiller by the same procedure.
- C. Clean the boiler by the same procedure.
- D. After flushing, sterilize the domestic water system in accordance with Domestic Water Piping section.

3.13 TESTING

- A. Test all drain and waste lines with standing water test of twelve feet of head, held long enough to visually inspect each joint.

- B. Test all reduced pressure domestic water piping, condenser water, and chilled water piping at 150 psig hydrostatic pressure before connecting to unit.
- C. Test all high domestic water service lines to PRV, fire lines, radiant panel (embedded in concrete) and anti-freeze piping at 200 psig hydro static pressure.
- D. Test all air, oil and gas piping under 60 psig air pressure.
- E. Test all refrigeration piping under 150 psig pressure using oil pumped, dry nitrogen and tapping of joints if there is any loss of pressure, soap each joint to find leaks. Charge with 10 psig refrigerant and test with halide torch or electronic leak detector. Evacuate using vacuum pump to 500 microns and purge twice with oil pumped, dry nitrogen.
- F. F.
- G. All tests must be done to the satisfaction of the local authorities having jurisdiction, before covering.
- H. All hydrostatic tests to be held for a minimum of six hours without loss of pressure. Air tests to be held for a minimum of two hours without loss of pressure.
- I. Furnish all instruments required for testing.

3.14 EQUIPMENT START UP AND PLACING IN OPERATION

- A. Clean all ducts, pipes, equipment, controls etc., of plaster and other foreign debris.
- B. Before final acceptance, clean or replace all strainers, oil or grease all bearings and clean out all drains. Clean and recoat all permanent filters, replace throwaway type filters with new filters.
- C. The systems shall be put into operation.
 - 1. The Contractor shall verify that all controls are set to meet operating conditions specified.
 - a. Example: Boiler operating and limit controls set where specified.
 - 2. The contractor shall verify that all pieces of equipment are operable and that all sequences of control are being met.
 - 3. The contractor to adjust settings through 1st year as required by MECHANICAL ENGINEER.
- D. All packaged plumbing and medical gas equipment shall be started by the manufacturer or under the manufacturer's supervision. Start-up data shall be recorded in logs. Copies of start-up logs shall be forwarded to the Engineer and included in Operation and Maintenance manuals.

3.15 CLEANING

- A. Immediately prior to inspection for Substantial Completion, remove any remaining waste materials and rubbish from mechanical and electrical rooms. Remove protective coating, barriers and other protective devices, temporary work, and surplus materials.
- B. Leave mechanical rooms and similar unfinished spaces "Broom Clean." Dust equipment, ducts, pipes, and other mechanical and electrical work in mechanical rooms and similar unfinished spaces. Remove construction dirt and debris from interior of equipment, panels, disconnects, ductwork, etc. thoroughly in accordance with manufacturer's instructions.

- C. Upon completion of the contract all remaining materials and rubbish shall be removed from the building and premises and the work areas shall be left clean and free from stains, mortar, paint spots, etc.
- D. Upon completion of the work, put systems into service maintaining responsibility for the equipment during all testing operations including the lubricating and turning on and off of such apparatus

3.16 CLOSEOUT SUBMITTALS

A. OPERATION AND MAINTENANCE INSTRUCTIONS

- 1. Books of Operating and Maintenance Manuals shall be delivered to the Owner's authorized representative and the Owner instructed as to their use and the equipment involved.
- 2. Thirty (30) days Prior to Substantial Completion, submit operating and maintenance manuals for equipment to Engineer for approval. Assemble manuals into white, 3-ring binders. Insert laminated cover sheets, identifying each binder on the front and spine with all necessary information so that all volumes appear uniform and orderly (i.e. Project Name, Owner Project Number, Contractor/Architect/Engineer Information, Volume Number, General Contents Description such as Mechanical, Electrical, etc.)
- 3. Provide comprehensive table of contents indicating the contents of all volumes in each set. Organize and tab documents in an orderly sequence, based on the table of contents of the project manual. Within each section, organize alphabetically by system or subsystem. Include a section in the directory for each of the following: list of documents, list of systems, and list of equipment.
- 4. Include copy of each submittal, including Architect / Engineer's review comments, and subsequent resubmittals for record purposes, indicating the actual product installed. Include significant changes in the product delivered to project site and changes in manufacturer's written instructions for installation.
- 5. Provide organized warranty section in the lead binder (Contractor's option to provide separate binder.) Organize warranty documents into an orderly sequence in separate binder, based on the table of contents of the project manual. A copy of each warranty shall also be provided in the respective equipment section.
- 6. Provide organized equipment failure emergency section in the lead binder (Contractor's option to provide separate binder.) Organize into separate sections for each type of emergency and include all necessary steps for safe equipment shut-down and containment. Also, include all necessary contractor and vendor contact information including 24-hour call numbers.
- 7. Provide comprehensive contact list in the lead binder including contractor and subcontractor's names, addresses, telephone and contact person for Owner's use.
- 8. Include equipment start up logs for all equipment required to be checked out and initially started under manufacturer's supervision.
- 9. Provide manufacturer's complete data sheets including assembly drawings, spare parts lists, wiring diagrams, mechanical diagrams, installation diagrams, and instructions. Identify equipment in manual and cross-reference by including serial number of actual components.
- 10. In addition to Manufacturer's maintenance documentation, provide separate schedules for preventative and routine maintenance and service with standard time allotment. Include

service and lubrication requirements and list of required lubricants for equipment, application methods and frequencies.

11. Provide Preventative Maintenance (PM) schedule for checking all items such as belt drives, safety controls, motor running load amps, oil, refrigerant and grease charges. Include cleaning schedule of all strainers, traps, coils, tubes, etc.
12. Include record of spare parts provided including signature of Owner's representative showing acceptance of parts. Provide list of additional items recommended to be stocked as spare parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and including local sources of maintenance materials and related services.
13. Provide test reports from manufacturer start-up indicating systems to be operating properly, including TAB reports, thermographics surveys, etc.
14. Provide electronic copy of final operation and maintenance manuals in full color pdf format on CD/DVD. All files shall clearly indicate specific information related to actual products installed. File structure and naming shall be "user-friendly" and organized in a manner similar to the hard copy binders such that it may be intuitively navigated by users.
15. Approval will not be given for final payment until the tests, balancing and operating instruction portions have been completed.

B. AS-BUILT DRAWINGS

1. During the process of the work, maintain an accurate record of the installation of the mechanical systems.
2. At the completion of the Work, Engineer shall furnish Contractor with a complete set of the latest revised record drawings in reproducible form, and Contractor shall indicate thereon all as-built changes and such additional details necessary or appropriate to provide a complete reference document for use by Engineer. If variations and details cannot be shown clearly thereon, the Contractor shall prepare supplemental drawings adequate to impart the information. These additional drawings shall also be in reproducible form. The foregoing drawings collectively shall constitute the "As-Built" drawings for the Work.
3. All indications on "As-Built" drawings shall be executed in a legible manner at Contractor's cost, using methods and legend presentations compatible with the overall scheme of the record Drawings with respect to scale, drawing sheet sizes and sequential indexing. All changes shall be marked clearly in red and clouded.
4. Engineer shall review Contractor's "As-Built" drawings and notify Contractor of observed discrepancies or deviations. Contractor shall promptly correct and resubmit revised drawings for Engineer review. Completed "As-Built" drawings shall be delivered to Owner through Architect.

C. DEMONSTRATION AND TRAINING

1. Refer to Division 01 for additional requirements regarding Demonstration, Training, and O&M Manuals submittals.
2. Prepare and submit operating instructions, as required by Specification Sections, and instruct Owner's personnel in use and maintenance of operating equipment. Explain use operation of each system to the Owner's designated representative(s). Explain use of the O&M manuals in operating and maintaining the systems.
3. After installation is complete, schedule to meet and instruct Owner's designated personnel in use, operation, care, and cleaning of equipment. Demonstrate that each

system operates properly. Instructions shall be given only by qualified personnel, thoroughly familiar with use and maintenance of equipment.

4. Notify the Engineer in writing a minimum of 72 hours in advance of any scheduled Owner equipment training. Following all training, provide record of Owner training including the type of training, who conducted the training, and list of attendees. Include copy in each set of O&M manuals.
5. Owner training sessions shall be video recorded to DVD media. DVD's shall be clearly labeled indicating content of equipment covered by training, and copies provided as follows: one (1) copy to the Owner, one (1) copy to the Engineer, and one (1) copy shall be included in each set of O&M manuals.

D. WARRANTY

1. Guarantee all work including labor, material and equipment for this project for a period of one year from date of acceptance by Using Agency/Owner. Repair or replace any work found defective without cost to the Owner during the warranty period.
2. All materials and equipment shall be new unless otherwise specified.
3. Guarantee all workmanship, materials and equipment and replace any found defective without cost to the Owner, for one year after final acceptance, as defined in General Conditions.
4. Each warranty for longer than the one year described above (that comes with equipment used on the job) shall be passed on to the owner with dates of start and end of the warranty.

END OF SECTION 22 0010

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SECTION 22 0116 - DEMOLITION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of the systems including
 - a. Fixtures
 - b. Piping
 - c. Equipment
 - 2. Abandoning in-place below-grade construction.
 - 3. Disconnecting, capping or sealing, and abandoning in-place site utilities.
 - 4. Salvage of existing items for reuse or recycling by Owner.
- B. Related Sections:
 - 1. Section 011000 "Summary" for use of the premises and phasing requirements.
 - 2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
 - 3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
 - 4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

1.03 DEFINITIONS

- A. Abandon In-Place: Disconnect existing component from service and label as abandoned, but do not remove. Distribution systems and networks such as piping that are abandoned in place shall be labeled abandoned at intervals specified in Division 22 Section "Identification for Plumbing".
- B. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
- C. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.
- D. Remove and Reinstall: Detach items from existing construction, clean, prepare for reuse, and reinstall where indicated.

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

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated in this section or in the drawings, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified refrigerant recovery technician.
- B. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for infection control measures, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Building Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before the Work begins.
- F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.06 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.07 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

- C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project Site.
 - 1. Inspect and discuss condition of construction to be demolished.
 - 2. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review and finalize protection requirements.
 - 4. Review procedures for noise and infection control measures.
 - 5. Review procedures for protection of adjacent buildings.
 - 6. Review items to be salvaged and returned to Owner.

1.08 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to demolition area. Conduct demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with HVAC systems demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.09 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations. Comply with Section 013233 "Photographic Documentation."
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.02 PREPARATION

- A. Existing Services/Systems: Locate, identify, disconnect, and seal or cap off indicated systems serving areas to be demolished.
 - 1. Arrange shut off of systems/service with Owner.
 - 2. If systems/services are required to be removed, relocated, or abandoned that will affect adjacent occupied/operational portions of the building(s), then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 - 3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
- B. Existing Utilities: See civil and electrical Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- C. Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.

3.03 UTILITY SERVICES AND PLUMBING/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 - 1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 3. Disconnect, demolish, and remove Plumbing systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Label entire extents of system abandoned in place in accordance with Section 220553 "Identification for Plumbing Systems".
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.04 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exit access from existing buildings.
- B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
1. Do not interrupt existing utilities serving operating facilities unless authorized in writing by Owner.
 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.
 - a. Provide at least 10 days notice to occupants of affected buildings if shutdown of service is required during changeover.
- C. Temporary Protection: Erect temporary barriers to maintain pressure differentials necessary to meet the requirements of the Infection Control plan as required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."
1. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
 2. Provide HEPA filtered exhaust of the demolition area to maintain airflow direction across the temporary barrier from clean portions of the building to areas of demolition and construction activity.
- D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.05 DEMOLITION, GENERAL

- A. General: Demolish indicated systems completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and for at least 8 hours, or duration required by Owner and Fire Marshal, after flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

3.06 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of Plumbing systems systematically, from lower to higher level. Complete Plumbing systems demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Below-Grade Construction: Abandon below-grade construction. Cut below-grade construction below grade, cap, and grout flush with grade.
- D. Existing Utilities: Demolish and remove existing utilities, below-grade tanks, and below-grade utility structures.
 - 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 - 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.07 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.
- B. Repair fireproofing where hangers and supports have been removed.

- C. Patch holes and openings in walls, floors, ceilings and structure created by removal of piping.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3.09 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.10 SELECTIVE DEMOLITION SCHEDULE

- A. Existing Items to be Removed: All fixtures, piping and equipment as indicated in drawings.
- B. Existing Items to be Removed and Salvaged: Items of monetary value to the Owner as follows:
 - 1. Plumbing fixtures of salvage value, or otherwise deemed valuable to the Owner as service stock for like fixtures to remain elsewhere in unrenovated portions of the facility.
- C. Existing systems to be Abandoned In-Place: Specifically noted on drawings. Typically limited to distribution piping located in portions of the building where removal is not economically viable. Label systems as abandoned at intervals specified in Division 22 Section "Identification for Plumbing".
- D. Existing items to Remove and Reinstall: Specifically noted in drawings.
- E. Existing systems/services and items to Remain: All system not specifically noted as removed, demolished, or abandoned in place shall be considered existing to remain.

END OF SECTION 22 0116

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SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections
 - 1. Section 22 0010 "Plumbing General Provisions"

1.02 SUMMARY

- A. This section includes requirements:
 - 1. Requirements for general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Related sections:
 - 1. Section 230010 - HVAC General Provisions
 - 2. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
 - 3. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturer's Association, Inc.; 1990 (Reapproved 2000)
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
- C. NEMA MG 1 - Motors and Generators; National Electronic Manufacturers Association; 2007.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2011.

1.04 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.

- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Conform to NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather, moisture, and construction debris by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

1.08 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Comply with NEMA MG 1, Design B for centrifugal pumps and compressors.
- B. Electrical Service:
 - 1. Motors smaller than 1/2 HP: 115 volts, single phase, 60 Hz.
 - 2. Motors 1/2 horsepower and larger: 208 or 480 volts, three phase, 60 Hz.
- C. Motors 3/4 horsepower and larger, or motors used in outdoor application (regardless of horsepower) shall be three phase, 60 Hertz.
 - 1. Motors configured in duplex applications shall have an individual electrical circuit to each motor.
 - 2. Motor starter coils and control circuits shall be powered by 120 volt control transformers located within the motor starter enclosure. Refer to Division 26 Section "Enclosed Controllers".
- D. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Motors shall be of cast iron construction.
 - 3. Design for continuous operation in 104 deg F (40 deg C) environment.

- 4. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- E. Duty: Continuous duty at ambient temperature of 86°F and at altitude of 6600 feet above sea level.
- F. Maximum load factor: Select motors with maximum ratio of brake horsepower (BHP) to nameplate horsepower not exceeding 0.8.
- G. 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.
- H. All motors furnished shall be the manufacturer's premium efficiency design. The nominal efficiency and the minimum guaranteed efficiency shall be stamped on the nameplate of the motor. All efficiency testing and labeling shall be done in accordance with the NEMA MG 1 standard.
- I. All three phase motors shall be "Inverter Approved" or "VFD Approved" and stamped as such on the nameplate of the motor.
- J. Explosion-proof motors shall be UL approved and labeled for hazard classification, with over temperature protection.
- K. Visible nameplates must be stainless steel, indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, and efficiency.
- L. Wiring Terminations:
 - 1. Motor leads shall be stranded copper and shall be permanently identified and brought out into the motor terminal box through a neoprene gasket. Provide conduit opening suitable for locknut type connector. Include UL listed ground lug in terminal enclosure.
 - 2. For fractional horsepower motors where connection is made directly, provide conduit opening suitable for locknut type fitting in end frame.
- M. All motors that are used with VFDs shall have grounding brushes on the shaft of the motor. The terminal strip provided shall be tied to the building ground. Acceptable products: AEGIS SGR.

2.02 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Multispeed Motors: Separate winding for each speed.
- C. Rotor: Random-wound, squirrel cage.
- D. Starting Torque: Between 1 and 1-1/2 times full load torque.
- E. Starting Current: Six times full load current.
- F. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

- G. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- H. Bearings: Grease lubricated, anti-friction ball bearings with housings equipped with provision for relubrication, rated for minimum ABMA STD 9, L-10 life for 100,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- I. Sound Power Levels: To NEMA MG 1.
- J. Temperature Rise: Class B.
- K. Insulation: Class F or better.
- L. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- M. Motors shall be 1800 rpm unless indicated otherwise. Enclosures shall be totally enclosed unless noted otherwise. Motors rated two horsepower and larger shall be fan cooled, premium efficiency design.
- N. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- O. Motor Frames: NEMA Standard T-Frames. Stator frame and end brackets shall be a minimum of grade 25 cast iron construction.
- P. Other Frame designation (e.g "T" Frame) motor plate rating shall be selected such that the brake horsepower of the equipment to be driven, through the full range of operating conditions, not including the service factor in the motor rating, does not exceed 80 percent of the name plate rating.
- Q. "U" frame motor nameplate rating shall not be less than the brake horsepower of equipment to be driven, through the full range of operating conditions, not including service factor in the motor rating.
- R. Thermistor System (Motor Frame Sizes 254T and Larger): Three PC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor stator.
- S. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and stator surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- T. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- U. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.03 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers (VFDs): Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.04 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp and less than 5 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor (PSC).
 - 2. Electrically commutated motor (ECM).
 - 3. Capacitor start, capacitor run (CS/CR).
- B. Multispeed Motors: Variable-torque, ECM.
- C. Split phase motors shall have the following characteristics:
 - 1. Starting torque: Less than 150 percent of full load torque.
 - 2. Starting current: Up to seven times full load current.
 - 3. Breakdown torque: Approximately 200 percent of full load torque.
 - 4. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- D. Capacitor start motors shall have the following characteristics:
 - 1. Starting torque: Three times full load torque.
 - 2. Starting current: Less than five times full load current.
 - 3. Pull-up torque: Up to 350 percent of full load torque.
 - 4. Breakdown torque: Approximately 250 percent of full load torque.
 - 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor.
- G. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

- H. Motors 1/20 HP and Smaller: Shaded-pole type.
- I. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Motors located in exterior locations: Totally closed type.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.03 MOTOR DYNAMIC BALANCING

- A. Perform dynamic balancing and test motors for vibration after manufacture. Self excite vibration velocity of motor shall not exceed 0.157/0.06 inches per second at the bearing caps.

3.04 START UP

- A. Inspect, test and start each motor and align with a dial indicator to 0.002"

3.05 SCHEDULE

- A. NEMA Open Motor Service Factors and Maximum motor speeds.
 - 1. 1/6 - 1/3 HP: 1800 rpm: 1.35
 - 2. 1/2 HP: 1800 rpm: 1.25
 - 3. 3/4 HP: 1800 rpm: 1.25
 - 4. 1 HP: 1800 rpm: 1.15
 - 5. 1.5 - 150 HP: 1800 rpm: 1.15
 - 6. 3600 rpm motors are not acceptable.

END OF SECTION 22 0513

SECTION 22 0516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section Includes:
 - 1. Flexible-Hose Packless Expansion Joint
 - 2. Expansion-compensator packless expansion joints.
 - 3. Grooved-joint expansion joints.
 - 4. Pipe loops and swing connections.
 - 5. Alignment guides and anchors.
- B. Related Sections:
 - 1. 220529 - Hanger and Supports for Plumbing
 - 2. 220548 - Vibration and Seismic Control for Plumbing Systems

1.03 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
 - 5. General Note: After Preconstruction coordination and per the delegated design aspect of the above specification, the contractor shall engage appropriate design professional to select piping expansion compensation method for all hot piping and submit as a shop drawing.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of expansion joint, from manufacturer.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. All components applied in domestic water applications shall listed to comply with NSF 61 and NSF 14.

PART 2 - PRODUCTS

2.01 PACKLESS EXPANSION JOINTS

- A. Metal, Expansion-Compensator Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Flex-Weld, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex, Inc.
 - 2. Minimum Pressure Rating: 175 psignless otherwise indicated.
 - 3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2and Smaller: Solder joint threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
- B. Flexible-Hose Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Metraflex, Inc.
 - 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 - 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 - 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg Fratings.
 - 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with solder joint or flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

2.02 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advanced Thermal Systems, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Flexicraft Industries.
 - d. Flex-Weld, Inc.
 - e. Hyspan Precision Products, Inc.
 - f. Metraflex, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- D. Install rubber packless expansion joints according to FSA-NMEJ-702.
- E. Install grooved-joint expansion joints to grooved-end steel piping

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops as shown on drawings and diagrams.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 0516

SECTION 22 0517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Grout.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.02 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
 - 3. Wade
 - 4. Josam
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing. Provide underdeck clamp with clamping ring and set screws for securement of fitting to slab.

2.03 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or outer dimension of pipe insulation for insulated pipe. Coordinate sleeve sizes with requirements of Section 23 0711 "Insulation".
 - 3. Increase sleeve size as required to provide additional annular space for project specific seismic conditions. Coordinate sleeve sizes with requirements of Section 23 0548 "Vibration and Seismic Controls".
 - 4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 9200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Coordinate sleeve sizes with requirements of Section 23 0711 "Insulation".
 2. Increase sleeve size as required to provide additional annular space for project specific seismic conditions. Coordinate sleeve sizes with requirements of Section 23 0548 "Vibration and Seismic Controls".
 3. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 4. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 5. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 6. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Concrete Slabs above Grade:
 - a. Piping, All sizes: Stack-sleeve fittings.
 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 0517

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SECTION 22 0518 - ESCUTCHEONS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 0518

SECTION 22 0521 - THERMOMETERS AND PRESSURE GAUGES FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Light-activated thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gauges.
 - 5. Gauge attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.
- B. ASTM E 1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2007.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 METERS AND GAUGES MATERIALS

- A. Comply with requirements in "Schedules" Article for applications of meters and gauges for specific services.
- B. Meters and gauges and their appurtenances applied to potable-water systems shall comply with NSF 14 and NSF 61.

2.02 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Miljoco Corporation.
 - b. Terice, H. O. Co.
 - c. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Precision die cast aluminum; 9-inch nominal size.
4. Case Form: Adjustable angle.
5. Tube: Glass with magnifying lens front, filled with non-toxic, blue organic liquid. Red color not permitted due to similarity with red reflecting mercury.
6. Tube Background: Nonreflective aluminum with white finish and permanently etched scale markings graduated in deg F, V-shaped backing for optimum readability.
7. Lens: Acrylic to 300 deg F, glass above 300 deg F.
8. Stem: Aluminum, tapered to fit standard industrial thermowells and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - c. Connection: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.03 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Miljoco Corporation.
 - b. Terice, H. O. Co.
 - c. Weiss Instruments, Inc.
 - d. Case: High impact ABS black plastic.
 - e. Case Form: Adjustable angle.
 - f. Sensor: Glass passivated thermistor.
 - g. Recalibration: Internal potentiometer.
 - h. Display: LCD, black character, 0.50" high with gray background.
 - i. Illuminance: Bi-directional solar collectors, 35 lux.
 - j. Refresh rate: 10 seconds.
 - k. Scales: Deg F and deg C with user adjustable switch to select which scale range to display.
 - l. Case Form: Adjustable angle.
 - m. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - n. Stem: Aluminum, tapered to fit standard industrial thermowells and of length to suit installation.
 - 1) Design for Air-Duct Installation: With ventilated shroud.
 - 2) Design for Thermowell Installation: Bare stem.
 - o. Accuracy: Plus or minus 1 deg or 1% of reading.

2.04 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES or CSA.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 3/4, ASME B1.20.1 pipe threads.
 - 7. Internal Threads: ASME B1.1 screw threads, 1-1/4" thread to mate with the 1-1/4" male thread for liquid-in-glass and light-activated type thermometers.
 - 8. Bore: Diameter required to match thermometer bulb or stem.
 - 9. Insertion Length: Length required to match thermometer bulb or stem.
 - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.05 PRESSURE GAUGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Miljoco Corporation.
 - b. Terice, H. O. Co.
 - c. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - d. Weiss Instruments, Inc.
 - e. Standard: ASME B40.100.
 - f. Case: Stainless steel, sealed open-front; 4-1/2 inch nominal diameter.
 - g. Pressure-Element Assembly: Phosphor bronze bourdon tube, brass socket.
 - h. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - i. Movement: Mechanical, with link to pressure element and connection to pointer.
 - j. Dial: Nonreflective aluminum white finished with permanently etched black scale markings graduated in psi.
 - k. Pointer: Aluminum, black, adjustable
 - l. Lens: Acrylic.
 - m. Ring: Stainless steel.
 - n. Accuracy: Grade A, plus or minus 1 percent of full scale.

2.06 GAUGE ATTACHMENTS

- A. Pressure snubbers: For dampening of pressure pulsations to prolong gauge life. ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device consisting of sintered stainless steel with no moving parts. Include extension for use on insulated piping.
- B. Valves: Required on all pressure gauge installations. Brass ball or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads. Rated for service at 600 lbs WOG. All gauge cocks shall be the same.

2.07 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one the following:
 - 1. Miljoco Corporation.
 - 2. Trerice, H. O. Co.
 - 3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.08 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Miljoco Corporation.
 - 2. Trerice, H. O. Co.
 - 3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermowells with socket extending a minimum of 2 inches into fluid or to center of pipe, whichever is smaller, and in vertical position in piping tees. Enlarge pipes smaller than NPS 2-1/2 for installation of thermometer sockets. Account for thickness of insulation when determining thermowell and associated thermometer lengths.

- C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- D. Install thermowells with extension on insulated piping.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gauge for fluids.
- I. Install test plugs in piping tees.
- J. Install permanent indicators on walls or brackets in accessible and readable positions.
- K. Install connection fittings in accessible locations for attachment to portable indicators.
- L. In addition to locations shown on drawings, install pressure gauges at the following locations:
 - 1. Discharge of each pressure reducing valve.
 - 2. Suction and discharge of each pump. Provide valving and piping to allow pressure sampling at each pump with a single pressure gauge. Provide a third sampling connection and valve upstream of suction diffuser for pumps fitted with suction diffuser.
 - 3. Inlet and outlet of each strainer. Provide valving and piping to allow pressure sampling at each strainer with a single pressure gauge.
- M. In addition to locations shown on drawings, install thermometers at the following locations:
 - 1. Cold water inlet, hot water outlet and hot recirculation inlet of each water heating device.
 - 2. Two inlets and two outlets of each hydronic heat exchanger.
 - 3. Inlet and outlet of each thermal-storage tank.

3.02 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.04 THERMOMETER TYPE AND SCALE-RANGE SCHEDULE

- A. Provide liquid-in-glass thermometer of scale range based on system type as follows. Contractor option to provide light-activated thermometer for all systems:
 - 1. Domestic Cold Water: 0 to 120 deg F.
 - 2. Domestic Hot and Recirculation Water: 0 to 200 deg F.

3.05 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

- A. Provide Direct-Mounted, Metal-Case, Dial-Type Pressure Gauge with ranges as follows based on service:
 - 1. Domestic Cold Water, upstream of service water pressure reducing valve station: 0 to 200 psi.
 - 2. Domestic Hot, Cold and Recirculation, downstream of pressure reducing valve station: 0 to 160 psi.

END OF SECTION 22 0521

SECTION 22 0529 - HANGERS AND SUPPORTS FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes the following:
 - 1. Hangers and supports of plumbing piping and equipment are considered delegated design by Contractor. Design, Furnish and Install hanger and support systems for Plumbing Piping and Equipment.
 - 2. Metal pipe hangers and supports.
 - 3. Trapeze pipe hangers.
 - 4. Metal framing systems.
 - 5. Thermal-hanger shield inserts.
 - 6. Fastener systems.
 - 7. Pipe positioning systems.
 - 8. Steel Equipment supports.
- B. Related Sections
 - 1. Section 22 0548 - Vibration and Seismic Requirements For Plumbing Systems

1.03 PERFORMANCE REQUIREMENTS

- A. Structural support and anchor design detailing is the responsibility of the Contractor unless otherwise specified or indicated on drawings. Support and anchor design calculations shall be provided to the Architect or Engineer upon request.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.04 ACTION SUBMITTALS

- A. Shop Drawings: Submit, for approval, complete calculations and details for field fabricated support installations (trapeze hangers, metal framing systems, and equipment supports);

designed by a Registered Structural Engineer in the State in which the project is located.
Submittal shall include Engineer's Seal affixed thereto.

- B. Show fabrication and installation details and include calculations for the following; include Product Data for components.

1.05 GENERAL REQUIREMENTS

- A. Hangers, structural supports, and attachments shall include all labor, supplemental steel, or other smaterial necessary for support of pipe furnished by Contractor. Factory fabricated items shall be complete with nuts, bolts, washers, etc. Where type and size are not indicated, proper selection shall be determined by Contractor. Refer to Noise & Vibration Isolation section of this specification for special support and hanger requirements.
- B. Refer to architectural and structural drawings for type of structure. Do NOT hang/support any single point loads greater than 500 lbs. from steel beams/purlins; and NOT greater than 250 lbs. from concrete slab or steel bar joists; unless specifically noted otherwise on the structural drawings. Weights shall not exceed framing member allowance. Where this Contractor violates allowances, any and all resultant damage and costs to correct, as determined by the Architect/Engineer, will be borne by this Contractor.
- C. Supports include equipment anchoring to floor slab, brackets to wall, hangers to equipment supported from structure above, etc. Refer to drawings for equipment and locations.
- D. Supplemental steel spanning structural framing elements may be steel angles or channels specifically sized for equipment/pipe weight. Supports shall be sized with a minimum safety factor of 5 to 1, or as required by code; most stringent requirement shall apply. Contractor may provide supplemental supports as manufactured by Unistrut, B-Line systems, or approved equal.
- E. Hangers and supports shall conform to recommendations of Standard Practice No. 58 and 69 of Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS).
- F. All exterior supports, hangers, attachments, etc. shall be galvanized or stainless steel; including all accessories, fasteners, etc.

1.06 REFERENCES

- A. American Concrete Institute, ACI:
 - 1. ACI 301: Specifications for Structural Concrete for Buildings.
 - 2. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 3. ACI 347: Recommended Practice for Concrete Formwork.
- B. American Society of Testing and Materials, ASTM:
 - 1. ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement.
 - 2. ASTM A185: Welded Steel Wire Fabric For Concrete Reinforcement.
 - 3. ASTM C33: Concrete Aggregates.
 - 4. ASTM C150: Portland Cement.
 - 5. ASTM C171: Sheet Materials for Curing Concrete.
 - 6. ASTM C260: Air-Entraining Admixtures for Concrete.
 - 7. ASTM C309: Liquid Membrane Forming Compounds for Curing Concrete.

- 8. ASTM C404: Aggregates for Masonry Grout.
- C. American National Standards Institute, ANSI:
 - 1. ANSI/ASME B31.9: Building Services Piping.
- D. Concrete Reinforcing Steel Institute, CRSI:
 - 1. CRSI Manual of Standard Practice.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, MSS:
 - 1. MSS SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture.
 - 2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
- F. National Electrical Manufacturers Association, NEMA:
 - 1. NEMA ML 1: Metal Framing (Continuous Slot Metal Channel Systems).

1.07 REGULATORY REQUIREMENTS

- A. International Building Code and International Plumbing Code, 2012 version.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hangers and Supports:
 - 1. Mason Industries: www.mason-industries.com.
 - 2. Nibco: www.nibco.com.
 - 3. PHD Mfg, Inc: www.phd-mfg.com.
 - 4. Bang-It
 - 5. Wood-Knocker
 - 6. Drop-In Anchors
- B. Saddles and Shields:
 - 1. Mason Industries: www.mason-industries.com
 - 2. Pipe Shields, Inc: www.pipeshieldsinc.com.
 - 3. PHD, Mfg., Inc.: www.phd-mfg.com.

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Single Pipe Support: Provide factory fabricated horizontal piping hangers, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69.
 - 1. Type: Adjustable Steel Clevis; Type 1
 - 2. Use only one type by one manufacturer for each type of piping service.
 - 3. Select hangers and supports sized to exactly fit pipe size for bare piping; and to exactly fit around pipe insulation with saddle and shield for insulated piping.
 - 4. Provide rubber or neoprene lined pipe ring isolators and copper plated hangers and supports for copper piping systems.
 - 5. Size in accordance with MSS and manufacturer's recommendations, most stringent shall apply; minimum safety factor of 5.

6. Based on Anvil Fig. 260 for insulated pipe of any type, non-insulated ferrous alloy pipe and non-insulated plastic pipe; Anvil Fig CT-65 copper plated carbon steel light duty adjustable clevis hanger for non-insulated copper piping NPS 1/2 thru 4.
- B. Trapeze Pipe Supports: Allowed for parallel runs of piping.
 1. Shop- or Field-fabricated: Provide MSS SP-69, Type 59 pipe support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
 2. Factory-fabricated: Provide channel strut system, B-line B22 or heavier as required for load and/or span lengths. Provide steel blocking of varying thickness welded to channel under each sloped pipe as required to obtain proper pitch. Strut clamps, straps, and rollers shall be used to maintain proper alignment:
 - a. Clamps and straps: B-Line series B2000 or B2400.
 - b. Rollers: B-Line figures B218, B219, B379, B479 or B3126
- C. Pipe hangers and supports on insulated piping shall be installed outside the insulation and shall include insulation supports/inserts between the pipe and hanger/shield.
 1. Exception: Seismic restraint hangers and supports shall be installed in contact with the pipe. Insulation shall be carried over the hanger or support and sealed.

2.03 VERTICAL PIPING CLAMPS

- A. Provide factory fabricated vertical piping clamps, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69.
 1. Use only one type by one manufacturer for each type of piping service.
 2. Select vertical piping clamps to be sized to exactly fit pipe type and size of bare pipe.
 3. Provide rubber or neoprene line pipe ring and copper plated clamps for copper piping systems.
 4. Vertical risers shall be supported independently of horizontal branch hangers.
 5. Type:
 - a. At floor levels: MSS Type 8; two bolt riser clamp.
 - 1) Ferrous alloy and plastic pipe: Anvil Fig. 261 or Fig. 600/599; steel pipe/socket clamp.
 - 2) Copper pipe: Anvil Fig. CT-121; copper pipe riser clamp; carbon steel with copper finish.
 - b. Intermediate support between floor levels when floor to floor level exceeds maximum vertical distance allowable between supports: MSS Type 42; four bolt riser clamp; required in addition to riser clamps at floor levels. Provide with shear lugs welded to pipe, weldless eye nuts and hanger rods.

2.04 ATTACHMENTS

- A. Hanger Rod Attachments: Provide factory fabricated hanger rod attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 1. Use only one type by one manufacturer for each type of piping service.
 2. Select size of hanger rod attachments to suit hanger rods; size attachments to suit equipment/pipe hanger/rod and applied load.
 3. Provide copper plated hanger rod attachments for copper piping systems.
 4. Type: MSS Type 13 Steel Turnbuckles

- B. Building Attachments: Provide factory fabricated hanger rod and brace angle attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Size attachments to suit equipment/pipe hanger/rod size and applied load.
 - 3. C-Clamps: MSS Type 23.
 - 4. Steel Brackets:
 - a. MSS Type 31 for light duty.
 - b. MSS Type 32 for medium duty.
 - c. MSS Type 33 for heavy duty.

2.05 SADDLES AND SHIELDS

- A. Provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping.
- B. Acceptable Manufacturers:
 - 1. Anvil
 - 2. Cooper/B-Line
 - 3. TOLCO Pipe Shields
 - 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 5. Value Engineered Products, Inc
- C. Size saddles and shields for exact fit to mate with pipe insulation
- D. Types:
 - 1. Protection Saddles: MSS Type 39, Anvil Fig 160-160A; fill interior voids with segments of insulation matching adjoining insulation.
 - 2. Protection Shields. MSS Type 40, Anvil Fig 167; length recommended by manufacturer to prevent crushing insulation, minimum length 12”.
- E. Insulation-Insert Material for Cold Piping: Utilize one of the following with vapor barrier:
 - 1. ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength, density ranging from 6.2 to 9.7 lb/cu. ft, and suitable for minus 450 to plus 800 deg F application.
 - 2. ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength, 6 lb/cu. ft. density, and suitable for minus 70 to plus 300 deg F application.
- F. Insulation-Insert Material for Hot Piping: Utilize one of the following, vapor barrier not required:
 - 1. ASTM C 533, Type I water-repellent treated calcium silicate with 100-psig minimum compressive strength, 15 lb/cu. ft. density, and suitable for 80 to 1200 deg F application.
 - 2. ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength, density ranging from 6.2 to 9.7 lb/cu. ft, and suitable for minus 450 to plus 800 deg F application.
 - 3. Permitted on low temperature heating water systems (200 deg F and lower) only, not permitted on steam and condensate: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength, 6 lb/cu. ft. density, and suitable for minus 70 to plus 300 deg F application.

- G. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- H. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- I. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 SPRING HANGERS AND SUPPORTS

- A. Provide factory fabricated spring hangers and supports, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each piping service.
 - 2. Select spring hangers and supports to suit pipe size and loading.
 - 3. Types:
 - a. Spring Cushion Hangers: MSS Type 48
 - b. Constant Supports: Selected to suit piping system; including auxiliary stops for erection and hydrostatic test, and field load adjustment capability.
 - 1) Horizontal Type: MSS Type 54
 - 2) Vertical Type: MSS Type 55
 - 3) Trapeze Type: MSS Type 56

2.07 FLASHING MATERIALS

- A. Provide locations of roof penetrations to Roofing Contractor for Coordination.
 - 1. Roofing Contractor provides flashing material specified in Division 07.
 - 2. Provide flashings for each penetration of plumbing systems through floors, roofs or waterproofing membranes.

2.08 SLEEVES

- A. Pipes through floors where no plumbing fixtures are installed: 18 gauge galvanized steel.
- B. Pipes through Beams, Walls, Fireproofing, Footings, Potentially Wet floors: Schedule 40 steel pipe or 18 gauge galvanized steel.
- C. UL Labeled Sleeves: Prefabricated with insulation and fireproofing.
- D. Sleeves through Fire and/or Smoke Walls: Comply with NFPA 90A
- E. Size sleeves to allow for expansion movement and to provide for continuous insulation.
- F. Prefabricated Wall Penetration Seals: Modular mechanical type; interlocking synthetic rubber links filling annular space between pipe and wall opening.
 - 1. Description: Bolt and pressure plate fasteners and rubber seal provide water tight seal between pipe and wall.
 - 2. Seal provides electrical insulation between pipe and wall.
 - 3. Based on: Thunderline Corporation Link Seal.

2.09 FIRE AND SMOKE PENETRATION SEALANT

- A. UL listed; flexible sealant or pre-fabricated metal device.

2.10 MISCELLANEOUS SUPPORT MATERIALS

- A. Metal Framing: NEMA Standard ML 1
- B. Structural Steel: ANSI/ASTM A 36, carbon-steel plates, shapes and bars; black and galvanized.
- C. Hanger Rods: Steel, threaded both ends, threaded one end, or continuously threaded.
- D. Cement Grout: Portland cement, ANSI/ASME C150, Type I or Type III, clean uniformly grades, natural sand, ANSI/ASTM C404, Size No. 2; mix ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water for placement and hydration, non-shrink, nonmetallic, suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
- E. Heavy Duty Steel Trapezes:
 - 1. Fabricate from steel shapes selected for applied loads.
 - 2. Weld steel in accordance with AWS standards.
 - 3. Pipe Guides: Factory fabricated cast semi-steel or heavy fabricated steel, including bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe.
 - a. Size guide and spiders to clear pipe, insulation and cylinder.
 - b. Guides Length: Recommended by manufacturer to allow required travel.

2.11 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with intumed lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer.
 - 7. Coating: Galvanized if required elsewhere in this specification section; otherwise, manufacturer's standard factory paint coating.

2.12 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.13 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.14 EQUIPMENT SUPPORTS

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

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments complete with inserts, bolts, rods, nuts, and washers in accordance with manufacturer's recommendations and as required to properly support piping from the building structure.
 - 1. Install hangers and supports to prevent sway, vibration, and sag.
 - 2. Support piping at drops to equipment to prevent stress at the equipment connections.
 - 3. Locate hanger within three feet of a direction change. Locate hangers within one foot of each horizontal elbow. Provide additional supports at each side of heavy valves and equipment. Valves NPS 3 and larger in horizontal piping shall be supported independently of the adjacent piping.
 - 4. Install hangers with minimum 1/2 inch clear space between finished covering and adjacent work.
 - 5. Use hangers with vertical adjustment range of 1-1/2 inch minimum suited for adjustment after piping is erected.
 - 6. Hanging of pipes from other trades (ie. Ductwork, conduits, ceiling suspension systems, medical equipment structural support systems, etc.) is not acceptable. Hanging and support of piping from other piping is not permitted, even of same trade.
 - 7. Adjust hangers and supports after insulation installation to provide uniform loading and to bring piping to proper levels and elevations.
 - 8. Use bracket type hangers fastened to walls to support piping running adjacent to walls and not supported from structure overhead.
 - 9. Perforated strap iron hangers and wire are not permitted for either temporary or permanent installation.
 - 10. Hangers and supports shall be securely fastened to structural members by beam clamps and clips, concrete inserts, anchors and all required accessories.

- B. Non-ferrous Piping: Copper plated and Plastic coated hangers and trapeze may contact non-ferrous piping. Ferrous hangers and supports, including trapeze members, must be isolated from non-ferrous pipe to prevent galvanic corrosion. Provide one of the following for installations mating ferrous hangers and supports with non-ferrous piping:
 - 1. Install split plastic shield, 6 inches long x 1/16 inch thick, 360 degree full circumference coverage with 225 deg F minimum rating between piping and hangers/supports.
 - 2. B-Line Vibra cushion clamps
 - 3. B-Line Iso Pipe rubber tape: Two (2) wraps extended 2 inches each side of hanger or clamp.
 - 4. Black electrical tape or PVC tape: Three (3) wraps extended 2 inches each side of hanger or clamp.
 - 5. Painting of hangers, clamps and trapeze is not considered acceptable substitute to the above.
- C. Piping installed below slab on grade: Secure to avoid floating of piping during concrete pour; submit means and methods of securement for Engineer approval. For insulated piping, securements shall not be allowed to pierce the insulation or jacketing under any circumstances.
- D. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.02 EQUIPMENT BASES AND SUPPORTS

- A. Concrete:
 - 1. Provide for major equipment reinforced concrete bases poured directly on structural floor slab 4 inches thick minimum, extended 4 inches minimum beyond machinery bedplates.
 - 2. Formwork: ACI 347.
 - a. Chamfer external corners of exposed concrete work.
 - b. Provide openings required by others as required.
 - c. Use manufacturer's templates or certified setting diagrams for placement of equipment anchor bolts and other mounting accessories.
 - d. Install accessories: Waterstops, expansion joints, and moisture barrier.

- e. Reinforcement: CRSI, Manual of Standard Practice.
 - f. Concrete Placement: ACI 301, 304.
 - g. Concrete Curing : ACI 301.
 - h. Concrete Finishing:
 - 1) Horizontal Surfaces: Float and trowel to level, smooth, uniform, dense finish; leave struck off surface untroweled; or scratch struck off surfaces.
 - 2) Curbs: Strip form while concrete is green; steel trowel to hard dense finish with corners, intersections and terminations slightly rounded and coved.
 - i. Concrete Grouting: Grout openings and recesses as indicated, around mechanical work using grouting mix, tamped, screened, troweled and cured.
 - 1) See individual equipment Sections for specification for fine grouting (nonshrink grout) of equipment base plates on foundation bases.
 - j. Field Quality Control: Contractor engages testing laboratory to take on site slump or compression tests to ensure compliance with specifications.
- B. Install lateral bracing with pipe hangers and supports to prevent swaying.
- C. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- D. Trapeze Hangers:
- 1. Where piping of various sizes are supported together by trapeze hangers, space hangers to accommodate maximum span permitted for smallest pipe; or install intermediate supports for smaller diameter pipe(s).
 - 2. Strut clamps, straps, and rollers shall be used to maintain proper alignment. Provide a clamp/strut/roller in each straight run of pipe every 30 feet on center.
- E. Vertical Piping Risers: Support vertical piping risers independent of adjacent hangers on horizontal branches.
- 1. Copper pipe: Support at the base of the riser and at each floor level; clamps not to exceed ten (10) feet on center. Provide additional supports for floor to floor heights exceeding 10 feet.
 - 2. Cast iron pipe: Support at the base of the riser and at each floor level; not to exceed fifteen (15) feet on center. Provide additional supports for floor to floor heights exceeding 15 feet.
- F. Pipe Movement: Install hangers and supports to allow controlled movement of piping systems
- 1. Install hangers and supports to allow controlled movement of piping systems; to permit freedom of movement between piping anchors; and to facilitate action of expansion joints, expansion loops, expansion bends, and similar entities.
 - a. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement is not transmitted to connected equipment.
- G. Polypropylene pipe: Support at maximum 32 inch intervals horizontally and five (5) feet on center vertically with additional support at base of riser and at each floor level.
- H. Insulated Piping: Provide thermal-inserts and shields.
- 1. Piping Operating above Ambient Air Temperature: Clamps supporting vertical piping may project through insulation. Hangers and supports for horizontal piping may not pass through insulation with the exception of saddles for roller support, seismic anchors, and seismic guides. Use thermal-hanger shield insert with clamp sized to match OD of insert.

2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
3. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
4. Install MSS SP-58, Type 39, protection saddles for above ambient services only at roller locations. Fill interior voids with insulation that matches adjoining insulation.
5. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
6. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 2 (DN 8 to DN 90): 12 inches (305 mm) long and 18 gauge (0.048 inch (1.22 mm) thick).
 - b. NPS 2-1/2 to NPS 6: 18 inches long and 16 gauge (0.06 inch thick).
 - c. NPS 8 to NPS 14: 24 inches long and 14 gauge (0.075 inch thick).
 - d. NPS 16 to NPS 24: 24 inches long and 12 gauge (0.105 inch thick).
7. Pipes NPS 8 (DN 200) and Larger:
 - a. Above ambient services: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - b. Below ambient services: Include reinforced cellular glass or polyisocyanurate insulation inserts of length at least as long as protective shield.
8. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 HANGER AND SUPPORT SPACING SCHEDULE

- A. Based on piping sizes and material types, install at maximum span distances, with minimum hanger rod sizes as follows. Specification based on individual piping supports and does not apply to trapeze systems:
 1. Horizontal Copper and Steel Piping:
 - a. NPS 1/2 to NPS 1-1/4: 6 feet maximum span, 3/8 inch diameter hanger rod.
 - b. NPS 1-1/2 to NPS 2: 10 feet maximum span, 3/8 inch diameter hanger rod.
 - c. NPS 2-1/2 to NPS 3: 10 feet maximum span, 1/2 inch diameter hanger.
 - d. NPS 4 to NPS 6: 10 feet maximum span, 5/8 inch diameter hanger rod.
 - e. NPS 8 to NPS 12: 10 feet maximum span, 7/8 inch diameter hanger.
 - f. NPS 14 and larger: 20 feet maximum span, 1 inch diameter hanger
 2. Horizontal Cast Iron Piping:
 - a. NPS 1-1/2 to NPS 2: 5 feet maximum span, 3/8 inch diameter hanger rod.
 - b. NPS 2-1/2 to NPS 3: 5 feet maximum span, 1/2 inch diameter hanger rod.
 - c. NPS 4: 5 feet maximum span, 5/8 inch diameter hanger rod.
 - d. NPS 6 to NPS 8: 5 feet maximum span, 3/4 inch diameter hanger rod.
 - e. NPS 10 to NPS 12: 5 feet maximum span, 7/8 inch diameter hanger rod.
 3. Hangers shall be placed adjacent either side of each piping joint and change in direction in addition to the above spacing criteria.

3.04 BUILDING ATTACHMENTS

- A. Space attachments within maximum piping spans indicated in MSS SP-69 and in spacing schedules this section. The most stringent, shortest distances shall apply.
- B. Install building attachments within concrete slabs or attach to structural steel.

C. Concrete Structure Attachments:

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
3. Structural attachments shall be approved box type inserts for concrete floors and roof decks.
 - a. Continuous inserts may be used for parallel lines of piping and equipment. Furnish spot or strip inserts with Styrofoam or cardboard filler strip to protect the cavity during pour and subsequent construction activities.
 - b. Anchor insert attachment to structure shall be installed in accordance with the manufacturer's recommendation for the application and approved by the Structural Engineer.
4. Self-drilling concrete anchors, Phillips Red Head Series, and powder-actuated fasteners, Hilti Fastening Systems or approved equal may be used only with prior approval by the Architect and Structural Engineer. If approved:
 - a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer.
 - b. Install fasteners according to powder-actuated tool manufacturer's operating manual.
5. Inserts and anchors shall not be installed in concrete pan construction between joists.

D. Steel Joist Attachments: Connect to top chord of all steel joists for all hangers from steel attached to joists.

E. Install additional building attachments when supporting additional concentrated loads, including valves, flanges, and strainers NPS 2-1/2 and larger and at changes in piping direction, guides, and expansion joints.

F. Anchors:

1. Install anchors at locations preventing stresses from exceeding ANSI/ASME B31; and preventing transfer of loading and stresses to connected equipment.
 - a. Install anchors at ends of principal piping runs and at intermediate points in pipe runs between expansion loops and bends.
 - b. Preset anchors to accommodate both expansion and contraction of piping.
2. Fabricate and install anchors by welding steel shapes, plates and bars to piping and to structure; in compliance with ANSI/ASME B31 and the American Welding Society (AWS).
3. Anchors for Expansion Compensators: Install anchors in accordance with expansion unit manufacturer's recommendations.
 - a. Limit piping movement and forces to maximums recommended by manufacturer for each unit.

3.05 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Brace and fasten with flanges bolted to structure.

1. Supports: Configured of structural steel members or steel piping and fittings.
2. Pipe Stands: Welded fabrication.
 - a. Provide flat plate supports for each leg, bolted to 6 inch high x 12 inch x 12 inch concrete base poured on floor. Alternatively, bolt support to floor and encase flange and anchor bolts in 6 inch high x 12 inch x 12 inch concrete base to be water proofed and sealed after curing.
 - b. Attach top of each leg to ceiling or roof structure as indicated or approved.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.
- D. Provide rigid anchoring for piping immediately after vibration connections to equipment and immediately after vibration isolator at transition from spring isolated piping rack to rigidly hung piping rack.

3.06 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.07 FLASHING

- A. Flash and counterflash where mechanical equipment passes through the roof, weather or waterproofed walls and floors.
 1. Coordinate with and accommodate specified roofing systems.
 2. Ensure compatibility with number and type of roofing plies.
 3. Vertical Surfaces: Lap flashings minimum 3 inches.
 4. Embed metal flashing flanges in roofing or composition flashing or stripping, by extending flanges minimum 6 inches for embedment.
 5. Pipes Through Outside Walls: Turn flange back into wall and seal.
 6. Curbs:
 - a. Provide curbs for mechanical roof installations 12 inches minimum high.
 - b. Flash and counterflash with steel, soldered and waterproofed.

3.08 SLEEVES

- A. Setting: Set sleeves in advance of concrete work; provide reinforcing around sleeves.

- B. Wet Areas: Extend sleeves through potentially wet floors 2 inch above finished floor level.
 - 1. Caulk sleeves full depth and provide floor plate.
 - 2. Insulation: Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and construction with noncombustible mineral wool insulation.
 - a. Provide tight fitting metal caps on both sides and caulk.
 - 3. Install chrome plated escutcheons where piping passes through finished surfaces.
 - 4. When duct sleeves pass through fire and smoke barriers, pack void space between duct and sleeve with fireproof mineral wool.
 - a. Provide sheet metal duct flanges at wall to cover openings.
 - 5. Prefabricated Wall Penetration Seals: Install and tighten seals in accordance with manufacturer's recommendations.
 - a. Ensure watertight pipe penetration.

3.09 FIRE AND SMOKE PENETRATION SEALANT

- A. Where supports pass through fire or smoke rated walls, partitions, floors, and ceilings, seal openings with UL rated materials.

3.10 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.11 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 9123 "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Exposed Steel Surfaces: Prime coat all exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.12 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Individual Hangers and Supports: Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
 - 2. Trapeze support system (MSS Type 59) with piping clamps or U-bolts (MSS Type 24) for support of pipes NPS 1/2 to NPS 30.
 - 3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 with vertical adjustment capability, steel-pipe base stanchion support and cast-iron floor flange.
 - 4. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 from two rods where longitudinal movement caused by expansion or contraction occurs.
 - 5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod where horizontal movement caused by piping expansion or contraction occurs.
 - 6. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 where horizontal movement caused by piping expansion and contraction occurs and with vertical and lateral adjustment capability during installation.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps or if additional intermediate supports between floors utilizing eyelets and additional hanger rod are required.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 4. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 0529

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SECTION 22 0548 - VIBRATION AND SEISMIC CONTROL FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes:
 - 1. Supplemental Steel bases.
 - 2. Vibration isolators.
 - 3. Seismic restraints.
- B. Related Sections
 - 1. 220529 Hanger and Supports for Plumbing

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Seismic Design Category: D; Refer to Structural Drawings for additional seismic design parameters.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - 3. Component Importance Factor: 1.5 for all systems deemed essential to the continued operation of the facility. All other systems, piping and equipment shall be assigned 1.0 Component Importance factor. Refer to Restraint schedule in Part 3 of this Section for items deemed essential to the continued operation of the facility.

1.04 SUBMITTALS

- A. Product Data: Provide schedule of vibration isolator type with location and load on each. Include spring constant, spring horizontal to vertical stiffness, maximum load capacity, color codes, neoprene durometer.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
- C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.
- D. Design: All spring isolators shall be completely stable in operation and shall be designed for not less than 30 percent reserve deflection beyond actual operating conditions. Open spring isolators shall be designed such that the horizontal to vertical spring stiffness ratio shall be 0.8 or greater for stability. All elastomeric isolators shall be of neoprene high quality synthetic rubber with anti-ozon and anti-oxidant additives. Steel components shall be cleaned and painted. All nuts, bolts, and washers shall be zinc electroplated. Structural steel bases

thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer.

Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 20 lb/sq. ft. applied to any exposed surface of the isolated equipment.

E. Delegated Design Submittal:

1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
3. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors,
4. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
5. Coordination Drawings; Show coordination of seismic bracing for Division 21, 22, 23 and 26 equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

F. Welding certificates.

G. Qualification Data: Professional engineer and testing agency

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An Independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910, 7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Vibration Mountings and Controls - Amber Booth
- B. Kinetics Noise Control, Inc
- C. Mason Industries

2.02 SUPPLEMENTAL STEEL BASES

- A. Single Steel I-beams
 - 1. Dimensions: Beams shall have a minimum section depth of 8% of the longest span between vibration isolator supports; down to a minimum of 6"; of size and shape required for the equipment to be supported.
 - 2. Loading: Structural steel base shall provide a rigid, distortion free, mounting base for supported equipment, which allows no excessive differential motion between the equipment and structural steel base.
 - 3. Anchoring: Provide prelocated and drilled anchor bolt holes into all structural steel bases to bolt down equipment.
- B. Steel Frames for Fans
 - 1. Steel base depth: Frames shall be steel beams or channels with a minimum depth of 8% of the longest span between isolators; minimum of 6" depth, maximum of 12" depth.
 - 2. Dimensions: Sized to prevent distortion and misalignment of the drive mechanism, and to limit beam deflection on the drive side of .05 inches at starting torque.
 - 3. Frame: Structure steel members and motor slide rail with holes predrilled to align with the fan and motor.
 - 4. Height Saving Brackets: Shall be welded to the structural steel base or shall be formed as an integral part of the frame. Provide the lowest possible mounting heights with a minimum 1/2" base clearance.

2.03 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Springs: Minimum horizontal stiffness equal to 80% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - 2. Spring Mounts: Provide with leveling devices, minimum 0.10 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 3. For equipment demonstrating lateral dynamic forces greater than 50% of the equipment weight, provide base plate and bolt holes for attachment to the support structure.
- B. Housed Spring Isolators with limit stops:
 - 1. Springs: Minimum horizontal stiffness equal to 80% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.

2. Spring Mounts: Provide with leveling devices, minimum 0.10 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Mounting: Complete with bolt holes in the base plates to provide for attachment to the equipment and support structure.
4. Maintain a minimum 1/4" clearance around restraining bolts or housing limit stops to prevent interference with spring action.
5. Housing: Steel enclosed constructed to carry equipment weight and serve as blocking during equipment installation.
6. Seismic Capacity: When used for seismic restraint application, provide all Code required restraint calculations. Maintain 1/8" clearance at restraining bolts.

C. Spring Hangers:

1. Springs: Minimum horizontal stiffness equal to 80 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Neoprene element: Molded with a rod isolation bushing and double deflection neoprene block.
3. Spring diameters and hanger box lower holes; large enough to permit the hanger rod to swing through 30 degree arc before contacting the isolator housing and short circuiting the spring.
4. Housing: Rectangular steel box constructed to carry the equipment weight without deformation.

D. Neoprene Pad Isolators:

1. Neoprene waffle pads.
 - a. Hardness: 30 durometer, or durometer required for specified load deflection.
 - b. Thickness: Minimum 3/4 inch (20 mm).
 - c. Maximum Loading: 50 psi.
 - d. Rib Height: Maximum 0.7 times width.
2. Configuration: Single layer, or waffle pads bonded each side of 1/4 inch (6 mm) thick steel plate.
3. For equipment demonstrating lateral dynamic forces greater than 50% of the equipment weight, provide base plate and bolt holes for attachment to the support structure.

2.04 SEISMIC RESTRAINTS

A. Seismic Snubbers:

1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding all combined static and dynamic forces, both direct and response amplified during a seismic event.

B. Seismic Cable Brace

1. Seismic Restraint: In the installed condition the restraint system shall be structurally capable of withstanding all combined static and dynamic forces, both direct and response amplified, during a seismic event. Restraint shall take place in all suspended modes and

limit travel by a 1/8 - 1/4 inch slack in the aircraft cable. Equipment shall be bolted to building structure to resist all applicable seismic forces.

2. Installation: Cable braces shall be utilized for suspended piping and mechanical equipment in conjunction with spring hangers or suspended ductwork or piping. Cables shall be installed at 45 degree or alternate angles to suspend equipment. Motion shall be restricted in two horizontal directions and in the downward vertical direction.
3. Submittals: Shall provide all seismic load calculations and drawings demonstrating compliance with the governing criteria. If limited access prevents installation at 45 degrees, seismic calculations shall be submitted to demonstrate compliance with alternate angles.

C. Seismic Rod Clamp

1. Seismic Restraint: Hanger rod steel angle and locking bolts used in conjunction with spring hangers or suspended ductwork or piping. In the installed condition the reinforcement system shall be structurally capable of withstanding all combined static and dynamic buckling forces, both direct and response amplified, during a seismic event.
2. Installation: Shall be in accordance with manufacturers' seismic load calculations, and rod clamp spacing based on rod diameter with a minimum of 3 clamps per rod.
3. Submittals: Shall include all seismic load calculations and drawings demonstrating compliance with the governing criteria.

D. Neoprene Washer-Bushing

1. Applications: For seismic relief at spring or neoprene isolator baseplate bolt holes.
2. Submit: Durometer according to ASTM D676; tensile strength and percent elongation at break according to ASTM D412; over aging hardness, tensile strength and elongation at break according to ASTM D573; and compression set according to ASTM D395.

E. General Requirements for Restraint Components

1. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
2. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
3. Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
4. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
5. Resilient Isolation Washers and Bushings: Oil-and water-resistant neoprene.
6. Maximum 1/4-inch air gap, minimum 1/4-inch thick resilient cushion.
7. Channel Support System: MFMA-3, shop- or field fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
8. Restraint Cables: A3TM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and belts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
9. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

10. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
11. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
12. Resilient isolation Washers and Bushings: One-piece, molded, Oil-and water-resistant neoprene, with a flat washer face.
13. Mechanical Anchor Bolts: Drilled in and stud-wedged or female-wedged type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488, Minimum length of eight times diameter.
14. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.05 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
- B. Design requirements: Lowest possible mounting height with no less than 1-inch clearance above the floor, include equipment anchor bolts and auxiliary motor slide bases or rails.
- C. Include supports for suction and discharge elbows for pumps.
- D. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- E. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- F. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
- G. Design requirements: Lowest possible mounting height with no less than 1-inch clearance above the floor, include equipment anchor bolts and auxiliary motor slide bases or rails.
- H. Include supports for suction and discharge elbows for pumps.
- I. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- J. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- K. Fabrication: Fabricate steel templates to hold equipment anchor-bolt cleaves and anchors in place during placement of concrete. Obtain anchor-belt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installation and Quality Control: Except as otherwise indicated, the contractor shall comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading. Remove space blocks and similar devices intended for temporary protection against overloading during installation. Anchor and attach units to structural supports and equipment as required. Adjust leveling devices as required where leveling uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Where equipment base frames are specified, install base frames on isolator units so that a minimum of 1/2" clearance below the base will result when the supported equipment has been installed and loaded for operation. (2" clearance for inertia bases). The contractor shall adjust all vibration isolators after the system has achieved full operating weight so that: no vibration isolation element is short circuited; no undue stress is applied to the equipment, connected piping or structure; and no noise is transmitted to any support structure, connected surface or adjacent environment. After equipment installation and operation, it shall be the contractors' responsibility to demonstrate that the isolation system meets all of the criteria specified in this Section and on the Drawings, and has been properly installed.
2. On housed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
4. Where fan/duct flexible duct connectors are used, provide pairs of horizontal thrust restraint springs on centrifugal fans with more than 6.0 inches WC total static pressure, and on hanger supported, horizontally mounted axial fans with more than 3.0" W.C. total static pressure.
5. Provide isolated or integral seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 1/8 inch maximum clearance.
6. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for the first three points of support.

3.02 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. General

1. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
2. Equipment Restraints:
 - a. Install seismic snubbers on Plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

- b. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - c. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
 - 3. Piping Restraints:
 - a. Seismically restrain all of the following piping:
 - 1) Gas piping, including Vacuum, and compressed air piping that is 1" I.D. or larger.
 - 2) Piping located in boiler rooms, and mechanical equipment rooms that is 1 1/4" OD and larger
 - 3) All other piping 2 1/2" diameter and larger.
 - 4. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 5. Longitudinal restraints shall be at 80" maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 6. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction,
 - 7. For all gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
 - 8. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
 - 9. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
 - 10. Branch lines may not be used to restrain main lines.
- B. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor Installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors. Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- C. Seismic Restraint Exclusions
 - 1. Piping

- a. All piping less than 1-1/2" in diameter except those listed below
- b. All gas piping and LNG gas piping less than 1" I.D.
- c. All piping in boiler and mechanical equipment rooms less than 1-1/4" I.D.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. All major rotating and reciprocating mechanical equipment (5 HP and larger) shall be mounted with spring isolators with a minimum of 2 inch static deflection.
- B. All piping connected to rotating and reciprocating shall be mounted with spring isolated hangers within the mechanical room or 50 feet whichever is greater.
- C. All piping and ductwork shall be mounted with spring isolated hangers at the bottom of all shafts greater than 3 floors.
- D. Seismic restraint of equipment must not inhibit vibration isolation.
- E. Housed spring mounts that accommodate both vibration and seismic requirements shall be submitted for review prior in acceptance.
- F. The following Plumbing Systems require restraint based on specified Seismic Design Category and Building Occupancy Category.
 - 1. Natural gas piping.
 - 2. Piping and piping trapeze systems weighing more than 5 lb / ft.
 - 3. Equipment weighing more than 20 lb.
 - 4. Equipment weighing 400 lb or less and having a center of mass located 4 ft or lower above floor level.
- G. The following Plumbing Systems are considered essential for the continued operation of the facility and shall be seismically restrained:
 - 1. Domestic Water Piping systems, all types and temperatures.
 - 2. Waste, Vent and Storm Piping Systems, including Overflow.
 - 3. Medical Gas Piping systems, including Vacuum and all associated equipment, controls and Alarms.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Sections for related piping materials for piping flexible connections.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency; Engage a qualified testing agency to perform tests and inspections.
- B. Tests and inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
- C. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
- D. Test to 90 percent of rated proof load of device.
- E. Measure isolator restraint clearance.
- F. Measure isolator deflection.
- G. Verify snubber minimum clearances.

END OF SECTION 22 0548

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes
 - 1. Equipment Nameplates.
 - 2. Pipe Labels.
 - 3. Valve Tags.

1.03 REFERENCE STANDARDS

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturers catalog literature for each product required.
- B. Valve Tag Layout: Provide sample drawing of proposed valve tag with letter sizing and arrangement.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Valve numbering scheme.
- E. Closeout submittals: Valve tag chart included in O&M's and valve tag chart in frame for mounting in location determined by Owner.

1.05 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceiling and similar concealment.
- D. Coordinate identification methods with facility's standards for consistency with methods in use elsewhere in the existing facility.

PART 2 - PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Provide identifying devices for the following piping systems and associated equipment:
 - 1. Domestic Water:
 - a. Cold (CW)
 - b. Hot (HW)
 - c. Hot Recirculation (HWR)
 - d. 140 deg F Hot (HW-140)
 - 2. Sanitary (W)
 - 3. Vent Piping (V)
 - 4. Gas (G) both medium (MG) and low pressure (LG)

2.02 EQUIPMENT NAMEPLATES

- A. Manufacturers:
 - 1. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 2. Mifab, Inc.: www.mifab.com.
 - 3. Seton Identification Products: www.seton.com.
- B. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch.
 - 3. Background Color: Black.
 - 4. Thickness: 1/8 inch.
- C. Label Content: Include equipment's Drawing designation where drawing designation is unique or unique. Where equipment number is not unique in the drawing set (ie multiple water heaters tagged as WH-1), submit proposed unique designation system for use in identifying each individual piece of equipment.
- D. Equipment labeling requirements do not apply to plumbing fixtures.

2.03 TAGS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com.
 - 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 3. Mifab, Inc.: mifab.com.
 - 4. Seton Identification Products: www.seton.com.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: 0.032-inch minimum thick brass with predrilled or stamped hole for attachment hardware. Letters to be stamped; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Tag Lettering size: Minimum 1/4 inch height for name of units where viewing distance is less than 24 inches, 1/2 inch minimum height for distances up to 72 inches, and proportionately

larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

- E. Valve Tag Fastener: Brass wire link or beaded chain with S-hook.
- F. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.
- G. Valve Tag Content: On each valve tag include system designation (ie CW = Cold Water), numerical valve designation, (ie -001), and valve vintage (ie 2014) to designate year of installation.

2.04 PIPE LABELS

- A. Comply with ANSI/ASME A13.1.
- B. Label all piping systems with factory-fabricated, preprinted, color-coded, with lettering indicating service type and pipe size, and showing flow direction.
- C. Construction type and Lettering size shall be based on pipe or pipe covering approximate sizes.
 - 1. Pipes or Pipe covering 3/4" and smaller: Letter size 1/2 inch, permanent phenolic tags or precoiled label similar to 1 inch through 2-1/2 inch size below shall be used.
 - 2. Pipe or Pipe covering size 1 inch to 2-1/2 inch diameter: Letter size 3/4 inch; label constructed of flexible, precoiled, semi-rigid plastic, pre-formed to cover full circumference of pipe or pipe covering and to attach to pipe without fasteners or adhesive.
 - 3. Pipe or Pipe covering size 2 inch to 6 inch diameter: Letter size 1-1/4 inch; label constructed of flexible, precoiled, semi-rigid plastic, pre-formed to cover full circumference of pipe or pipe covering and to attach to pipe without fasteners or adhesive.
 - 4. Pipe or Pipe covering size 6 inch to 10 inch diameter: Letter size 2-1/2 inch; label constructed of flat, semi-rigid plastic, and attached to pipe with heavy duty nylon ties.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Brady Corporation
 - 2. Kolbi Pipe Marker Co.
 - 3. Marking Services, Inc.
 - 4. MIFAB, Inc.
 - 5. Seton Identification Products.
- E. Pipe Label Contents:
 - 1. Include identification of the the piping service (fluid conveyed) utilizing common English terminology (ie. Domestic Cold Water) in lieu of abbreviations used on Drawings.
 - 2. Indicate Pipe Size at every label location.
 - 3. Indicate fluid flow direction with Arrows at every label location.
 - 4. Pressure of contents where various pressure systems of same fluid occur on project (ie 100 psi Compressed air vs. 60 psi Compressed air).

- 5. Temperature of contents where various temperatures of same fluid occur on project (most typically Domestic Hot Water, 120 deg F versus 140, 160 or 180 deg F Domestic Hot Water).
 - 6. Insulated piping shall be labeled as "Non-Asbestos".
- F. Schedule for banding and labeling of pipe and conduit will conform to ANSI/ANSI A13.1.

2.05 VALVE AND DEVICE IDENTIFICATION CEILING TAGS

- A. Description: 3/4" x variable length vinyl tape for use with thermal transfer printer. 3.0-mil film, acrylic-adhesive with polished face. UV, moisture, and abrasion resistant with 5 year warranty.
- B. Provide clear plastic printed ceiling identification tags for plumbing and medical gas system valves, controls, and other above ceiling equipment components. In addition, label all above ceiling components at each location in accordance with the Facility's established standards.
- C. Color: Ceiling tags to be clear background with black letters.
- D. Contents: Label text shall be in accordance with the Facility's established standards.
- E. Install ceiling identification tags per the Facility's established standards.
- F. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair the bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- B. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 EQUIPMENT NAMEPLATE INSTALLATION

- A. Locate equipment nameplates where accessible, readily visible, and not subject to physical abrasion by routine equipment maintenance.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- C. Identify pumps, compressors, tanks, water heaters, water treatment devices, medical gas manifolds, and all other pieces of equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

3.03 PIPE LABEL INSTALLATION

- A. Install plastic pipe markers in accordance with manufacturer's instructions. Lettering shall be visible from the floor.

- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; equipment rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch where flow pattern is not obvious.
 - 3. Near penetrations through walls, floors, ceilings and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 15 feet in areas of congested piping.
- C. Pipe Label Color Schedule:
 - 1. Domestic Cold Water Piping: Green background with White lettering.
 - 2. Domestic Hot and Hot Water Recirculation Piping: Yellow background with Black lettering.
 - 3. Sanitary Wast and Vent Piping: Green background with White lettering.
 - 4. Natural Gas Piping: Yellow background with Black lettering.

3.04 VALVE TAG INSTALLATION

- A. Install tags with corrosion resistant chain on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Use tags in addition to labels on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Identification of Non-potable CW piping not to exceed 4 feet.
- C. Identify valves in main and branch piping with tags.
- D. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to valve.

END OF SECTION 22 0553

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SECTION 22 0593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Balancing Domestic Hot Water Recirculation Piping Systems:
 - 2. Control system verification.

1.03 DEFINITIONS

- A. Adjust: To regulate fluid flow rate via pump speed or balance valve position.
- B. Balance: To proportion flows within the hot water distribution and recirculation system, including mains, submains, risers, and branch connections according to indicated quantities.
- C. BAS: Building automation systems.
- D. NEBB: National Environmental Balancing Bureau.
- E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- F. Report Forms: Test data sheets for recording test data in a logical order.
- G. Static Head: The pressure due to the weight of the fluid above the point measurement. In a closed system, static head is equal on both sides of the pump.
- H. TAB: Testing, adjusting, and balancing.
- I. TABB: Testing, Adjusting, and Balancing Bureau.
- J. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- K. Terminal: A point where the controlled medium, water, enters or leaves the distribution or recirculation system, and also including branch recirculation connection points to the recirculation system.
- L. Test: A procedure to determine quantitative performance of systems or equipment.
- M. TDH: Total dynamic head.

1.04 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.05 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, Plumbing systems installers, and other mechanics to operate plumbing systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after pressure tests and system sterilization and disinfection has been completed.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 - 2. Verify that balancing devices, such as test ports, gauge cocks, flow control devices, balancing valves and fittings, are required by the Contract Documents. Verify quantities and locations of the balancing devices are accessible and appropriate for effective balancing and efficient system and equipment operation.
- B. Examine the approved submittals for plumbing systems and equipment.
- C. Examine design data including Plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about Plumbing system and equipment controls.
- D. Examine equipment performance data including pressure reducing valves, back pressure valves, flow control devices, balance valves and pump curves.
- E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- F. Examine test reports specified in individual system and equipment Sections.
- G. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- H. Examine balance- and flow-control valves for proper installation for their intended function.
- I. Examine system pumps to ensure absence of entrained air in the suction piping.
- J. Examine operating safety interlocks and controls on Plumbing equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of Plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Verify pressure tests on water distribution systems have been satisfactorily completed.
 - 2. Piping is complete with all devices and fixtures installed.
 - 3. Systems are flushed, filled, and air purged.
 - 4. Strainers are pulled and cleaned.
 - 5. Sterilization and Disinfection is complete.
 - 6. Shutoff and balance valves have been verified to be 100 percent open.
 - 7. Pumps are started and proper rotation is verified.
 - 8. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - 9. Variable-frequency controllers' startup is complete and safeties are verified.
 - 10. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.
- B. Cut insulation, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 22 0719 "Plumbing Piping & Equipment Insulation."
- C. Mark equipment and balancing devices, valve position indicators, 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) units.

3.04 GENERAL PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.

- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.05 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- G. Verify that memory stops have been set.

3.06 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.07 TOLERANCES

- A. Set water flow rates within the following tolerances:
1. Domestic-Hot Water Recirculation Flow Rate: Plus or minus 10 percent.

3.08 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.

2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Water flow rates.
 2. Pipe and valve sizes and locations.
 3. Balancing stations.
 4. Position of balancing devices.
- E. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.

- k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
 - F. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.
- 3.09 VERIFICATION OF TAB REPORT
- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
 - B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
 - E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

F. Prepare test and inspection reports.

3.10 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 22 0593

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SECTION 22 0716 - PLUMBING EQUIPMENT INSULATION

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SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes insulating the following plumbing equipment & piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping, including recirculated hot-water piping.
 - 3. Supplies and drains for handicap-accessible lavatories and sinks.
 - 4. Section includes jackets and accessories for the above insulation systems.
- B. Related Sections:
 - 1. Section 220529 "Hangers and Supports."
 - 2. Section 221005 "Plumbing Piping."

1.03 REFERENCE STANDARDS

- A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.
- B. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- C. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2004.
- D. ASTM C 534/C 534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2008.
- E. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2007.
- F. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 1990 (Reapproved 2004).
- G. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2007.
- H. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.
- I. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.
- J. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.

- K. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- L. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Shop Drawings: Include sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at 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.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of Work specified in this Section with minimum 5 years of experience, and employing skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work:
 - 1. Piping Mockups:
 - a. One ten foot section of NPS 2 straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
 - e. Four support hangers including hanger shield and insert.

- f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 - 2. Fixture mockups:
 - a. One fully plumbed ADA accessible hand washing station with protective shielding guards.
 - 3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 5. Obtain Architect's approval of mockups before starting insulation application.
 - 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 8. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
- 1. Supply and Drain Protective Shielding Guards: ICC A117.1

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Deliver material to site in factory fabricated containers with manufacturer's stamp or label, showing fire and smoke hazard ratings of products.
- C. Store material in original wrappings and protect from weather and construction traffic.
- D. Protect against sun, dirt, water, chemical and mechanical damage.
- E. Remove damaged insulation from project site. Do not install.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

1.08 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 0529 "Hangers and Supports for Plumbing."

- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.09 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

2.01 INSULATION MATERIALS

- A. Comply with requirements in Part 3 Schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
 - 1. Products: Subject to compliance with requirement, provide the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 - 2. 'K' Value: 0.37 at 100 deg F.
 - 3. Service Temperature: Up to 900 deg F.
 - 4. Water Vapor Permeability: 0.005 perm inch.
 - 5. Water Absorption: 0.2 percent by volume, maximum.
 - 6. Block Insulation: ASTM C 552, Type I.
 - 7. Special-Shaped Insulation: ASTM C 552, Type III.
 - 8. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 9. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2 with factory-applied all service vapor barrier jacket with self sealing lap (ASJ-SSL) consisting of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 10. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Use molded tubular material wherever possible.
1. Products: Subject to compliance with requirement, provide products by one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
 2. 'K' Value: 0.27 at 75 deg F.
 3. Minimum Service Temperature: -40 deg F.
 4. Maximum Service Temperature: 220 deg F.
 5. Water Vapor Permeability: 0.08 perm-inch
 6. Connection: Waterproof vapor barrier adhesive.
 7. Polyethylene and Polyolefin materials are not acceptable.
- H. Mineral-Fiber: Mineral or glass fibers bonded with a thermosetting resin.
1. Pipes: Pre-Formed Pipe & Tank Insulation complying with ASTM C 547, Type I, Grade A with factory-applied all service vapor barrier jacket with self sealing lap (ASJ-SSL) consisting of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Moisture vapor transmission when tested in accordance with ASTM E96 of 0.02 perm-inches.
 2. Fittings: Premolded PVC cover ASTM E-84 listed for 25/50 max with premolded mineral fiber insert.
 3. Equipment: Mineral-fiber board insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ.
 4. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Mansville.
 - b. Knauf Insulation.
 - c. Owens Corning.
 5. 'K' Value: ASTM C 177, 0.23 at 75 deg F.
 6. Maximum service temperature: 850 deg F.
 7. Maximum moisture absorption: 0.2 percent by volume.
- I. Adhesives:
1. General: For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Cellular Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents with a service temperature range of minus 100 to plus 200 deg F.
 3. Flexible Elastomeric Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with MIL-A-24179A, Type II, Class I.
 4. Mineral Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 5. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 6. PVC Jacket Adhesive: Compatible with PVC jacket.

2.02 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, vapor barrier unless otherwise indicated. Comply with ASTM C 921, Type II, non-vapor barrier where permitted.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Mansville.
 - b. Proto Corporation.
 - c. Speedline Corporation.
 - 2. Adhesive: As recommended by jacket material manufacturer and in compliance with adhesive requirements above.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate:
 - a. Shapes: 45- and 90-degree, short- and long radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.
 - b. P-trap and supply covers for lavatories shall be factory-fabricated removable assemblies.
- C. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14. Factory cut and rolled to size. Finish and thicknesses are indicated in field applied jacket schedules.
 - 3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240. Factory cut and rolled to size. Finish and thicknesses are indicated in field applied jacket schedules.
 - 4. Moisture barrier for galvanic corrosion protection:
 - a. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - c. Metal Jacket Fitting Covers: Factory-fabricated fitting covers of same material, finish, and thickness as jacket for:
 - 1) Elbows: Pre-formed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 2) Tee covers.
 - 3) Flange and union covers.
 - 4) End caps.
 - 5) Beveled collars.
 - 6) Valve covers.

- 7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Pittsburgh Corning Corporation.
 - b. Polyguard Products, Inc.

2.03 CORNER ANGLES

- A. PVC Corner Angles: 30 mils, thick, minimum 1 inch by 1 inch, PVC according to ASTM D 1784 Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 inch by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Anglers: 0.024 inch thick, minimum 1 inch by 1 inch, stainless steel according to ASTM A 167 or ASTM A Type 316.

2.04 TAPE

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Venture Tape.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division.
 - b. Compac Corporation.
 - c. Venture Tape.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Venture Tape
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.05 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Insul-Tect Products, Co.; a subsidiary of MVG Molded Products.
 - b. McGuire Manufacturing.
 - c. Truebro; a brand of IPS Corporation.
 - d. Zurn Industries, LLC.
 2. Description: Manufactured plastic wraps with insulation for covering accessible plumbing fixture hot- and cold-water supplies, trap and drain piping. Fully removable without the use of tools and re-usable. Comply with Americans with Disabilities Act (ADA) and ANSI 117.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify systems to be insulated have been tested and are free of defects before applying insulation materials.
 2. Verify that surfaces are clean and dry, with foreign material removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Before covering, test and approve piping.
- B. Entire surface: Clean and dry at time of installation.
 1. Insulation: dry before and during application.
 2. Finish with systems at operating conditions.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturer's instructions. Provide insulation materials, accessories and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Vapor barrier is required for all below ambient services. Seal joints, seams, and penetrations in below ambient services insulation systems at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are required, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4-inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints
- P. For above ambient services, do not install insulation on the following. For below ambient service, install removable/replaceable insulation systems on same:
1. Vibration control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2-inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations and at Underground Exterior Wall Penetrations requiring insulation both sides.: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions and seal in compliance with requirements of Section 07 8413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations: Install insulation continuously through floor penetrations and seal in compliance with requirements of Section 07 8413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- F. Butt insulation and seal joints and breaks with vapor barrier tape or sealer and 2 inches of foil adhered over joint.
- G. Inserts and Shields:
1. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 2. Insert location: Between support shield and piping and under the finish jacket.
 3. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 4. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- I. Exposed piping in Mechanical Equipment Rooms or unfinished spaces less than 7 feet above finished floor: Provide with aluminum jacket.
- J. Exposed piping in Public Spaces: Provide with PVC jacket and fitting covers.
- K. Insulate all exposed piping, including thermostatic mixing valves, below fixtures scheduled for use by the disabled in accordance with ADA.

- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- M. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- N. Install removable insulation covers at strainers, flanges, unions, pumps and other items requiring service access. Installation shall conform to the following.
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes.
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application
- E. Mineral-fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. Mineral fiber insulated pipes conveying fluids above ambient temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- 3.09 EQUIPMENT AND PIPE INSULATION & JACKETING SCHEDULE
- A. Provide insulation types and thicknesses as follows: Where more than one type of insulation is permitted on a piping system type, only one type shall be permitted in the installation. Contractor shall define intended type in submittals and utilize only that type in the project.
- 3.10 PIPING SERVICES
- A. Roof drain and overflow piping, including drain bodies: All pipe sizes; Mineral Fiber or Flexible Elastomeric, 1 inch thick.
- B. Domestic Cold Water, RO Water, Non-potable Cold Water: Mineral Fiber or Flexible Elastomeric, thicknesses based on pipe size as follows:
1. NPS 1/2 to NPS 4: 1/2 inch thick.
 2. NPS 5 and larger: 1 inch thick.

- C. Domestic Hot Water, Recirculated Hot Water, Tempered water; Application temperature 100 to 140 deg F, Mineral Fiber, thickness based on pipe sizes as follows:
 - 1. NPS 1/2 to NPS 2: 1 inch thick
 - 2. NPS 2-1/2 and larger: 1-1/2 inches thick
- D. Domestic Cold Water, Outdoors or in unheated outdoor ceiling plenums, Above Ground: All piping sizes, Mineral Fiber, 2 inches thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, Stops, and thermostatic mixing valves beneath fixtures designed to be accessible to people with disabilities: Flexible elastomeric with plastic jacketing, removable, resealable insulation kit, 1/2 inch thick.
- F. Floor Drains, Traps and Sanitary Drain Piping Receiving cooling coil condensate and equipment drain water below 60 deg F: Mineral Fiber or Flexible Elastomeric, 1/2 inch thick.

3.11 JACKETING

- A. All Indoor in mechanical rooms and anywhere exposed to view - Provide PVC insulation jacketing in addition to specified factory-applied jacket.
- B. All Outdoors Services - Provide 0.016" stucco embossed aluminum or Type 304 stainless steel jacket in addition to specified factory-applied jacket.

END OF SECTION

SECTION 22 1005 - PLUMBING PIPING

PART 1 - GENERAL

1.01 Related Documents

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

1.02 SUMMARY

- A. This section includes requirements:
 - 1. Pipe, pipe fittings, valves, and connections for piping systems.
 - a. Domestic water.
 - b. Storm water.
 - c. Sanitary Sewer.
 - d. Chemical Resistant (Acid) Waste & Vent Piping
- B. Related requirements
 - 1. Section 078413 - Fire Stopping.
 - 2. Section 083113 - Access Doors and Frames.
 - 3. Section 220553 - Identification for Plumbing Piping and Equipment.
 - 4. Section 220719 - Plumbing Piping Insulation.
 - 5. Section 221119 - Domestic Water Piping Specialties

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; The American Society of Mechanical Engineers; 2005.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- F. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; The American Society of Mechanical Engineers; 2006.
- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2001.

- H. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; 2007 (ANSI/ASME B31.1).
- I. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2004 (ANSI/ASME B31.9).
- J. ASME (BPV IV) - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2007.
- K. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2007.
- L. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- M. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.
- N. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2007.
- O. ASTM B 32 - Standard Specification for Solder Metal; 2004.
- P. ASTM B 42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2002.
- Q. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- R. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.
- S. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2008.
- T. ASTM C 76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2008.
- U. ASTM C 425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings; 2004.
- V. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.
- W. ASTM C 700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated; 2007a.
- X. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.
- Y. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.
- Z. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.
- AA. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).

- BB. ASTM D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2006.
- CC. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2007.
- DD. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- EE. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 2003.
- FF. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).
- GG. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).
- HH. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- II. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2005.
- JJ. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2004.
- KK. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002.
- LL. MSS SP-67 - Butterfly Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002a.
- MM. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2006.
- NN. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2005.
- OO. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- PP. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.
- 1.04 SUBMITTALS
 - A. See Section 01 3000 - Administrative Requirements, for submittal procedures. 013300 - Submittal Procedures.

- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Wyoming Chapter 3
- B. Valves: Manufacturer's name and pressure rating marked on valve body. Valves shall be manufactured in the United States of America
- C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- D. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with State of Iowa plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- D. The Contractor shall notify the manufacturer's representative prior to installing any copper pressure seal joint fittings and obtain representative's guidance in any unfamiliar installation procedures. The manufacturer's representative of copper pressure seal fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from the manufacturer's recommended installation practices.
- E. Installer Qualifications: All installers of copper pressure seal fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted for Project Record prior to any installations.
- F. All pressure sealed joint couplings, fittings, flanges, valves, and specialties shall be of the same manufacturer. Pressure sealing tools shall be of the same manufacturer as the pressure sealed pipe fitting components.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

- B. Provide structural fill bedding for buried pipe.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A 74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets.
- B. Polyvinyl Chloride Pipe (PVC)
 - 1. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness Solid Wall Pipe SDR 35.
 - 2. PVC plastic in accordance with ASTM D 1784, Cell Classification 12454 B.
 - 3. Integral Bell and spigot type rubber gasket push joint fittings conforming to ASTM D 3212 and ASTM F 477.

2.02 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A 74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hubeless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. Copper Tube: ASTM B 306, Type DWV or ASTM B 88 (ASTM B 88M), Type L (B), 1-1/2" and under only.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.32, solvent.
 - 2. Joints: ASTM B 32, alloy Sn50 solder.
 - 3. Cast iron pipe to be used on 2" and above unless otherwise noted.
- D. PVC Pipe and Fittings
 - 1. Solid-Wall Pipe: Schedule 40 ASTM D 2665, drain, waste, and vent.
 - 2. Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - 3. Joining Method: ASTM F 656 adhesive primer with ASTM D 2564 solvent cement.
 - 4. Firestopping: Provide listed firestopping components, materials and methods at PVC piping penetrations of fire-resistance rated construction. Submit complete firestopping detailing package. All fire-stopping materials and methods to be of a single manufacturer.

2.03 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Pipe: Type K soft tempered copper
 - 1. Fittings: ASME B16.22 wrought copper and bronze, or brass flare fitting, ANSI B16.26
 - 2. Joints: AWS A5.8, BCuP copper/silver braze.

- B. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: Ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, rubber gasket with 3/4 inch diameter rods.

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper, Solder Joint
 - 1. Sizes: 1/2" - 2-1/2"
 - 2. Hard Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
 - 3. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 4. Joints: ASTM B 32, alloy Sn95 solder.
 - 5. Union: Copper cast alloy, hexagonal-socket body with ball and socket, metal to metal seating surface. Solder or threaded joints
 - 6. Flanges: ASME B16.24 Class 150, with solder joints
- B. Copper, Press-Seal Joint - NOT PERMITTED
- C. Cross linked Polyethylene (PEX) Tubing - NOT PERMITTED
- D. Copper, Groove Coupled
 - 1. Sizes: 2-1/2" -8"
 - 2. Copper Piping: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
 - 3. Copper Fittings: Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand casting ANSI B16.18 and UNS-C89836
 - 4. Joints: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity. NSF 61 approved EPDM gaskets suitable for hot and cold water.
 - 5. Pressure rating: 250 psig
- E. Stainless Steel, Grooved Coupled
 - 1. Sizes: 2-1/2" -10"
 - 2. Stainless Steel Piping: ASTM A 312/ A 778; type 304 Schedule 10S
 - 3. Stainless Steel Fittings: Type 304 grooved stainless steel with dimensions matching pipe.
 - 4. Joints: Stainless steel mechanical groove-end couplings. Stainless steel housing and bolts with NSF 61 approved EPDM gaskets suitable for hot and cold water.
 - 5. Pressure rating: 250 psig

2.05 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D 3034 SDR 35.
 - 1. Fittings: PVC.
 - 2. Joints: Push-on, using ASTM F 477 elastomeric gaskets.

2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D 2665 or ASTM D 3034.

1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D 2564 solvent cement.

2.07 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A 74 service weight.
 1. Fittings: Cast iron.
 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 1. Fittings: Cast iron.
 2. Joints: Neoprene gaskets and Type 301 stainless steel clamp-and-shield assemblies.

2.08 CHEMICAL RESISTANT SEWER WASTE AND VENT PIPING (ACID)

- A. Pipe and fittings: Corrosive waste drainage system, conforming to ASTM F1412, flame-retardant polypropylene. The polypropylene material shall conform to ASTM D4101. The pipe and fittings shall be joined using the piping manufacturers No-Hub/Plain End couplings. The pipe shall be supplied in factory grooved 10-ft. length. Fittings are to meet or exceed Schedule 40 dimensions.
 1. Manufacturers: Orion Blueline: Flame Retardant Polypropylene
- B. Above Grade Couplings: Coupling shall have 300 series stainless steel outer band and 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117.
- C. Below Grade Couplings: Socket Fusion Fittings; Socket fusion systems conform to ASTM F1412. Socket fusion fittings meet or exceed ASTM D2657 standards.
- D. Polypropylene fittings shall be manufactured from polyolefin material in accordance with ASTM D4101. PVDF fittings are manufactured from Kynar® brand of PVDF resin meeting ASTM D3222.

2.09 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3" and Over:
 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.10 VALVES IN WATER LINES

- A. Check Valves 3 Inches Diameter and Larger: Class 125 # SWP, 200 # WOG, horizontal swing check, body and cap shall be of ASTM A126 cast iron, bronze trim, bolted cap, flanged ends, MSS SP-71.
- B. Check Valves 2.5 Inches Diameter and Smaller: Class 125 # SWP, 200 # WOG, horizontal swing check, body and cap shall be of ASTM B62 cast bronze, TFE disc, integral bronze seats, MSS SP-80.
- C. Silent Globe Style Check Valves 2.5 Inches Diameter and Larger: 200 # WOG minimum, body shall be of ASTM A126 Class B cast iron, center guided, stainless steel spring and screws, bronze disc, bronze seat.
- D. Spring Lift Check Valves 2 Inches Diameter and Smaller: 200 # WOG minimum, bronze body, in-line spring lift check, TFE or Buna disc, integral seats.
- E. Ball Valves 3 Inches Diameter and Smaller: 600 # WOG, 150 # SWP, 2 piece body style, CP brass tunneled ball, reinforced TFE seats, hex gland follower, bronze body of ASTM B584, blow-out proof stem, lever handle.
- F. Butterfly Valves 2.5 Inches Diameter and Larger: 200 # WOG, cast iron or ductile iron full lug body, aluminum bronze, bronze, cast/ductile iron with nickel plating/edge or stainless steel disc, 316 SS stem, field-replaceable phenolic-backed EPDM cartridge style seat ("boot" type seats without backing rings are not acceptable), blow-out proof stem, MSS SP-67. Valves shall be bi-directional bubble tight shut off rated for in-line service as well as dead end service with either mating flange removed. Valves 6" and smaller shall be provided with a 10 position lever handle, 8" and larger with a geared rotary hand wheel operator.

2.11 GATE VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Up To and Including 2 1/2 inches:
 - 1. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.
- C. 3 Inches and Larger:
 - 1. MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.12 BALL VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. Construction, 3 Inches and Smaller: MSS SP-110, Class 150, 600 WOG, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends.

2.13 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Crane Co.: www.cranevalve.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Construction: 2-1/2" and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
- C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.14 FLOW CONTROLS

- A. Manufacturers:
 - 1. ITT Bell & Gossett: www.bellgossett.com.
 - 2. Griswold Controls: www.griswoldcontrols.com.
 - 3. Taco, Inc: www.taco-hvac.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

2.15 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Up to 2 Inches:
 - 1. MSS SP-80,, bronze body and cap, bronze swing disc with rubber seat, solder ends.
- C. Over 2 Inches:
 - 1. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.16 SILENT GLOBE STYLE CHECK VALVES

- A. Manufacturers:

1. Hammond Valve: www.hammondvalve.com.
2. Nibco, Inc: www.nibco.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Up to 2 Inches:

1. MSS SP-80,, bronze body and cap, bronze swing disc with rubber seat, solder ends.

C. Over 2.5 Inches:

1. MSS SP-71, 200 # WOG, iron body, bronze swing stainless steel springs and screws, flanged ends.

2.17 SPRING LOADED CHECK VALVES

A. Manufacturers:

1. Hammond Valve: www.hammondvalve.com.
2. Crane Co.: www.cranevalve.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. 2" diameter and smaller: 200# WOG,bronze body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.18 RELIEF VALVES

A. Pressure Relief:

1. Manufacturers:
2. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated, ASME rated.

B. Temperature and Pressure Relief:

1. Manufacturers:
 - a. Cla-Val Co: www.cla-val.com.
 - b. Henry Technologies: www.henrytech.com.
 - c. Watts Regulator Company: www.wattsregulator.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.19 STRAINERS

A. Manufacturers:

1. Armstrong International, Inc: www.armstronginternational.com.
2. Green Country Filtration: greencountryfiltration.com.
3. WEAMCO: www.weamco.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Size 2 inch and Under:

1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.
- D. Strainers must be rated acceptable for domestic water service.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to 22 0719 - Plumbing Piping Insulation
- G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083113 - Access Doors and Frames.
- H. Establish elevations of buried piping outside the building to ensure not less than 52 inches of cover.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- J. Provide support for utility meters in accordance with requirements of utility companies.
- K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section

- L. Excavate in accordance with Section 312000
- M. Backfill in accordance with Section 312333
- N. Install bell and spigot pipe with bell end upstream.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Install water piping to ASME B31.9.
- Q. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
- R. Sleeve pipes passing through partitions, walls and floors: Refer to Section 220529.
- S. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- T. Pipe Hangers and Supports:
 - 1. Refer to Section 22 0529 - Hangers and Supports for Plumbing
- U. Provide valve stem extensions to coordinate with insulation thickness.

3.04 EXECUTION

- A. Workmanship
 - 1. The piping shown on the drawings shall be installed complete and shall be of the size shown on the drawings. When a size is not indicated, request the pipe size from the Architect/Engineer. All piping shall be installed parallel or perpendicular to the building construction. All piping shall be installed to allow for expansion.
- B. Joints
 - 1. All pipe shall be reamed to full pipe diameter before joining. Joints may be sweat or screwed, or if the pipe size is 2-inch or larger, the joints may be welded at the Contractor's option. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only. Use only shaped nipples, welding laterals, or saddle fittings for intersection welding of branches to mains. Valves and specialties shall have screwed or flanged joints.
- C. Testing
 - 1. The entire system shall be tested per international plumbing code.
 - 2. Owner or owners representative to be present for all testing and provide final signature of acceptance.
 - 3. See sytem startup.
- D. Sectionalized

1. The pipe may be tested a section at a time in order to facilitate the construction. Contractor will provide necessary fittings to accomplish testing.

E. Protection

1. The piping shall be protected at all times from dirt and moisture. During storage on the job site or construction, keep pipe ends plugged or capped to prevent dirt or moisture from entering the pipe.

3.05 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install ball valves for throttling, bypass, or manual flow control services.
- D. Provide spring loaded check valves on discharge of water pumps.
- E. Provide soft-seat check valves upstream of backflow preventers.
- F. Provide flow controls in water recirculating systems where indicated.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 2 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION

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SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Strainers.
 - 5. Outlet boxes.
 - 6. Drain valves.
 - 7. Water-hammer arresters.
 - 8. Air vents.
 - 9. Trap-seal primer valves.
 - 10. Trap-seal primer systems.
 - 11. Specialty valves.
 - 12. Flexible connectors.
- B. Related Requirements:
 - 1. Section 22 1005 - Plumbing Piping
 - 2. Section 22 4000.02 - Plumbing Fixtures (WSH)

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.04 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks
 - b. Cash Acme
 - c. Conbraco Industries, Inc
 - d. FEBCO
 - e. Rain Bird Corporation
 - f. Toro Company (The)
 - g. Watts; a Watts Water Technologies company
 - h. Zurn Industries, LLC
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrowhead Brass Products
 - b. Cash Acme
 - c. Conbraco Industries, Inc
 - d. Legend Valve
 - e. MIFAB, Inc
 - f. Prier Products, Inc
 - g. Watts; a Watts Water Technologies company
 - h. Woodford Manufacturing Company
 - i. Zurn Industries, LLC
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks
 - b. Conbraco Industries, Inc
 - c. FEBCO
 - d. Flomatic Corporation
 - e. Toro Company (The)
 - f. Watts; a Watts Water Technologies company
 - g. Zurn Industries, LLC
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: as required
6. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.05 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco
 - b. FEBCO
 - c. Watts; a Watts Water Technologies company
 - d. Zurn Industries, LLC
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 - NPS 3/4.
5. Body: Bronze.
6. End Connections: Union, solder joint.

7. Finish: Chrome plated.

B. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc
 - b. Watts; a Watts Water Technologies company
 - c. Woodford Manufacturing Company
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

C. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc
 - b. FEBCO
 - c. Flomatic Corporation
 - d. Watts; a Watts Water Technologies company
 - e. Zurn Industries, LLC
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.06 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc .
 - b. Flo Fab Inc .
 - c. ITT Corporation .
 - d. NIBCO Inc.
 - e. Schneider Electric USA, Inc .
 - f. TACO Incorporated .
 - g. Watts; a Watts Water Technologies company .
2. Type: Y pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.07 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Manifold, Thermostatic, Water Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company .

- b. Powers; a division of Watts Water Technologies, Inc
 - c. Symmons Industries, Inc .
 - 2. Description: Factory-fabricated, cabinet type, thermostatically controlled, water mixing-valve assembly in two -valve parallel arrangement.
 - 3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 - 4. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 - 5. Small-Flow Parallel: Thermostatic, water mixing valve.
 - 6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
 - 7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
 - 8. Pressure Rating: 125 psig minimum unless otherwise indicated.
 - 9. Cabinet: Factory fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.
 - 10. Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated
 - 11. Piping Finish: Copper.
- B. Individual-Fixture, Water Tempering Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme
 - b. Conbraco Industries, Inc
 - c. Honeywell Water Controls
 - d. Lawler Manufacturing Company, Inc
 - e. Leonard Valve Company
 - f. Powers
 - g. Watts; a Watts Water Technologies company
 - h. Zurn Industries, LLC
 - 2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
 - 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 - 4. Body: Bronze body with corrosion-resistant interior components.
 - 5. Temperature Control: Adjustable.
 - 6. Inlets and Outlet: Threaded.
 - 7. Finish: Rough or chrome-plated bronze.

2.08 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
- 1. Pressure Rating: 125 psig minimum unless otherwise indicated.
 - 2. Body: Bronze for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
 - 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 4. Screen: Stainless steel with round perforations unless otherwise indicated.
 - 5. Perforation Size: per usage.
 - 6. Drain: Pipe plug or Factory-installed, hose-end drain valve.

2.09 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company
 - b. Guy Gray Manufacturing Co., Inc
 - c. IPS Corporation
 - d. LSP Products Group, Inc
 - e. Oatey
 - f. Plastic Oddities
 - g. Symmons Industries, Inc
 - h. Watts; a Watts Water Technologies company
 - i. Whitehall Manufacturing
 - j. Zurn Industries, LLC
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company .
 - b. IPS Corporation
 - c. LSP Products Group, Inc .
 - d. Oatey
 - e. Plastic Oddities
2. Mounting: Recessed.
3. Material and Finish: Stainless-steelbox and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.10 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARCHON Industries, Inc

2. Armstrong International, Inc
3. Cooney Brothers, Inc
4. DynaFluid Ltd
5. Leonard Valve Company
6. Strahman Valves, Inc
7. T & S Brass and Bronze Works, Inc

B. Hot- and Cold-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Faucet Type: Blending valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough Bronze
7. Mounting: Wall, with reinforcement
8. Supply Fittings: Two NPS 3/4 gate, globe, or ball valves and check valves and NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc
 - b. Josam Company
 - c. MIFAB, Inc
 - d. Precision Plumbing Products, Inc
 - e. Sioux Chief Manufacturing Company, Inc
 - f. Smith, Jay R. Mfg. Co
 - g. Tyler Pipe; a subsidiary of McWane, Inc
 - h. Watts; a Watts Water Technologies company
 - i. Zurn Industries, LLC
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.

2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc
 - b. Precision Plumbing Products, Inc
 - c. Sioux Chief Manufacturing Company, Inc
 - d. Smith, Jay R. Mfg. Co
 - e. Watts; a Watts Water Technologies company
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.16 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems: Where flush valve type fixture is not in the immediate vicinity of floor drain trap requiring primer system, provide Trap-seal primer system. Include in Plumbing Division Bid, the cost to Electrical Contractor for electrical power required.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Precision Plumbing Products, Inc

2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: as required.
8. Size Outlets: NPS 1/2.

2.17 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flex-Hose Co., Inc
 2. Flexicraft Industries
 3. Flex Pression Ltd
 4. Flex-Weld Incorporated
 5. Hyspan Precision Products, Inc
 6. Mercer Gasket & Shim, Inc
 7. Metraflex Company (The)
 8. Proco Products, Inc
 9. TOZEN Corporation
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe

- diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
 - C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
 - D. Install balancing valves in locations where they can easily be adjusted.
 - E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
 - F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
 - G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
 - H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
 - I. Install water-hammer arresters in water piping according to PDI-WH 201.
 - J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
 - K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
 - L. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
 - M. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.
- 3.02 CONNECTIONS
- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
 - B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.03 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check, backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - 8. Double-check, detector-assembly backflow preventers.
 - 9. Water pressure-reducing valves.
 - 10. Calibrated balancing valves.
 - 11. Primary, thermostatic, water mixing valves.
 - 12. Manifold, thermostatic, water mixing-valve assemblies.
 - 13. Photographic-process, thermostatic, water mixing-valve assemblies.
 - 14. Primary water tempering valves.
 - 15. Outlet boxes.
 - 16. Hose stations.
 - 17. Supply-type, trap-seal primer valves.
 - 18. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 0553 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer [double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 1119

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SECTION 22 1319 - DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Floor sinks.
 - 4. Area drains.
 - 5. Trench drains.
 - 6. Sand/Oil Separator.
 - 7. Through penetration firestop assemblies.
 - 8. Roof flashing assemblies.
 - 9. Miscellaneous sanitary drainage piping specialties.
 - 10. Flashing materials.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.03 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide

consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 CLEANOUTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. Smith, Jay R. Mfg. Co.
 - 3. Tyler Pipe; Wade Div.
 - 4. Zurn Plumbing Products Group.
- B. Exposed Horizontal Cleanouts, HCO:
 - 1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 2. Size: Same as connected drainage piping
 - 3. Body Material: Hubless, cast-iron soil pipe test tee as required matching connected piping.
- C. Floor Cleanouts, FCO:
 - 1. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 2. Size: Same as connected branch.
 - 3. Coated cast iron internal gasketed ABS cleanout plug and adjustable ABS housing.
 - 4. Medium-duty scoriated secured round satin finish Nikaloy top.
 - 5. Heavy-duty for locations subject to vehicle traffic.
- D. Wall Cleanouts, WCO:
 - 1. Standard: ASME A112.36.2M. Include wall access.
 - 2. Size: Same as connected drainage piping.
 - 3. Round stainless steel wall access cover with screw and no-hub cleanout.

2.03 FLOOR DRAINS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. Smith, Jay R. Mfg. Co.
 - 3. Tyler Pipe; Wade Div.
 - 4. Zurn Plumbing Products Group.
- B. Floor Drains, FD-1:
 - 1. Description: General Purpose floor drain with stainless steel strainer
 - 2. Configuration: Bottom outlet.
 - 3. Standard: ASME A112.6.3.
 - 4. Body Material: Coated cast iron.
 - 5. Bottom Outlet with Seepage & Anchor Flange with clamping device.
 - 6. Strainer: 6" Round Stainless Steel, medium-duty with heel-proof slotted secured grate.
 - 7. Based on: Refer to Plumbing Fixture Schedule on Drawings.
- C. Floor Drains, FD-2:

1. Description: General purpose floor drain with polished nickel bronze strainer.
2. Standard: ASME A112.6.3.
3. Configuration: Bottom Outlet
4. Body Material: Coated Cast Iron
5. Bottom Outlet with Seepage & Anchor Flange with clamping device.
6. Strainer: 6 inch round, polished nickel bronze, light-duty strainer.
7. Based on: Refer to Plumbing Fixture Schedule on Drawings.

2.04 FLOOR SINKS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
 2. Smith, Jay R. Mfg. Co.
 3. Tyler Pipe; Wade Div.
 4. Zurn Plumbing Products Group.
- B. Floor Sink, FS-1:
1. Description: 12 inch x 12 inch x 6 inch deep floor sink.
 2. Configuration: Bottom outlet.
 3. Body Material: Cast iron, with white acid resisting porcelain enamel interior and top.
 4. Grate: Provide with full, 3/4 or 1/2 grate dependent upon presence, and quantity of indirect drains discharging to floor sink.
 5. Provide with white ABS anti-splash interior bottom dome strainer.
 6. Based on: Refer to Plumbing Fixtures Schedule on Drawings.

2.05 AREA DRAINS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
 2. Smith, Jay R. Mfg. Co.
 3. Tyler Pipe; Wade Div.
 4. Zurn Plumbing Products Group.
- B. Garage Area Drain, AD-1:
1. Description: 16 inch square top drain for garage drain application.
 2. Configuration: Bottom outlet with seepage pan and combination membrane flashing clamp and frame for heavy-duty slotted loose grate and suspended sediment bucket.
 3. Body Material: Coated cast-iron.
 4. Include Stainless Mesh Liner for Sediment Bucket.
 5. Based on: Refer to Plumbing Fixtures Schedule on Drawings.
- C. Plaza Area Drain, AD-2:
1. Description: 8 inch x 8 inch area drain
 2. Refer to Landscape Architectural Drawings for Drain specification.

2.06 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
 - 1. Refer to Firestopping and Fireproofing specifications for requirements.

2.07 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - 2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

2.08 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - 3. NPS 2: 4-inch- minimum water seal.
 - 4. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- B. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- C. Vent Caps:
 - 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2.09 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 100 feet.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.02 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fitting, according to Division 07 sections.
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having calking recess.

3.03 LABELING AND IDENTIFYING

- A. See Section 220553

3.04 PROTECTION

- A. Place plugs in ends of uncompleted piping at end of each day or when work stops.
- B. Protect drains during construction period to avoid clogging with dirt or debris and prevent damage from traffic or constriction work.

END OF SECTION 22 1319

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SECTION 23 0010 - HVAC (HEATING, VENTILATION AND AIR CONDITIONING) GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Consult them for further instructions and be governed by the requirements thereunder.
- B. Related Work is specified elsewhere in Divisions 21, 22, 25, 26, 27, and 28, and when issued by the Owner, is hereby incorporated.

1.02 GENERAL

- A. Work Included
 - 1. Furnish all labor, materials, equipment and related items, and perform all operations required to complete work within the intent of the Drawings and Specifications, whether or not specifically mentioned, and to deliver complete and fully operational HVAC systems subject to the conditions of the Contract. For this reason, the Contractor shall visit the premises and site before submitting their bid and familiarize themselves with the areas in which work is to be done.
 - 2. Provide HVAC, plumbing, and electrical details not mentioned or shown which are necessary for the successful operation of all systems. Clean, sterilize, flush and fill all systems per requirements to make them operational; including labor and materials for final fill of water, refrigerant, oils, grease, gases, antifreeze and brine.
 - 3. Set all sleeves and cut and patch all miscellaneous holes necessary for the convenient, orderly and proper installation of the work. Required holes through masonry and concrete construction with an area less than thirty five (35) square inches (20 inch diameter and less) shall be considered miscellaneous holes.
 - 4. Any work installed without regard to the work of other crafts which must, in the opinion of the Owner or Architect/Engineer, be moved to permit the installation of other work, shall be moved and replaced as a part of this work at no additional charge.
 - 5. Rough-in for and connect, as shown on the drawings, all equipment furnished by the
 - 6. Prove satisfactory operation of all equipment and controls to the Owner, Architect, and/or Engineer upon request.
- B. Work Not Included
 - 1. Certain labor and materials may be furnished and/or installed under other divisions of these specifications. Coordinate with other trades and arrange the work to make the parts fit together. The following items are to be accomplished under other divisions of these specifications.
 - a. Temporary Heat: See "Temporary Heat" Paragraph in this Specification Section and Division 01.
 - b. Roof Curbs: See "Roof Curbs" Paragraph in this Specification Section.
 - c. Concrete: See "Concrete" Paragraph in this Specification Section.

- d. Electrical Equipment and Wiring: See "Electrical Equipment and Wiring for Mechanical Division" Paragraph in this Specification Section.
 - e. Temporary Water and Toilet: See Division 01.
- C. Equipment Furnished by Owner
- 1. The Owner will award contracts, which will commence concurrently with this contract. Specifically this work will include:
 - 2. Equipment Installation: Refer to appropriate drawings for equipment furnished by the Owner.
 - 3. Rough-in service pipes to locations as required by architectural and mechanical drawings and equipment shop drawings. Provide service valves on all pipes except waste and vent pipes, plug or cap these. Final connections to equipment shall be made by Contractor.

1.03 QUALITY ASSURANCE

- A. Qualifications of Contractor: All materials and equipment shall be new and all work shall be executed with the maximum speed consistent with current accepted trade practices. Furnish materials and equipment promptly after authorization to proceed, and proceed with work in progress with the other contractors on the project. Perform all work included in the contract in a manner that will not cause interferences or delays to, or interfere with, the progress of other contractors.
- B. At all times when work is not in progress, keep all open ends of pipe, ductwork, fittings, equipment and fixtures securely closed and protected.
- C. All welding shall comply with the requirements and recommendations of the American Welding Society and all applicable codes.
- 1. Weld metal shall not project creating an obstruction.
 - 2. Chip or grind out all weld metal before re-welding.
 - 3. Caulking / preening of welds is not allowed.
 - 4. Welder shall be certified to work on service/utility type indicated.

1.04 CODES AND REFERENCED STANDARDS

- A. Comply with specified Codes and Standards. If conflict exists between Codes or Standards and drawings, project specifications manual or addenda requirements, the most stringent requirement shall apply.
- B. Conform to the installation rules and regulations of the standards listed including all subsequently published amendments thereto issued prior to the date of the bidding documents.
- C. Conform to the requirements of all local, state and federal agencies which have authority over the project. Include all items of labor and material required to meet such requirements regardless of the failure to specify in the project manual or indicated on the drawings each individual item.
- D. All equipment, apparatus and systems shall be rated, tested, fabricated and installed with the applicable industry standards.
- E. The applicable portions of the following standards form a part of this project manual to the same force and effect as if repeated herein.

1. American National Standards Institute (ANSI)
 2. International Mechanical Code (IMC)
 3. International Plumbing Code (IPC)
 4. American National Standards Institute (ANSI)
 5. American Gas Association, Inc. (AGA)
 6. American Society for Testing Materials (ASTM)
 7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
 8. American Society of Mechanical Engineers (ASME)
 9. American Water Works Association (AWWA)
 10. National Electrical Code (NEC)
 11. National Electric Manufacturers Association (NEMA)
 12. National Fire Protection Association (NFPA)
 13. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 14. Underwriters Laboratories, Inc. (UL)
 15. Environmental Protection Agency (EPA)
- F. Conform to the International Building, Fire, and Mechanical Codes, 2012 edition.
- G. Conform to the International Energy Conservation Code, 2009 edition.
- H. Conform to applicable sections of NFPA 13 and NFPA 24.
- I. Conform to the National Electrical Code, 2011 Edition.
- J. Conform to the requirements of the Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) Standard 117.
- K. Conform to Colorado Department of Public Health and Environment, Health Facilities and Emergency Medical Services Division, "Standards for Hospitals and Health Facilities".
- L. Conform to requirements of the Facility Guidelines Institute (FGI) "Guidelines for Design and Construction of Healthcare Facilities", 2010 Edition. and the Joint Commission for Accreditation of Healthcare Organizations (JCAHO).
- M. All work shall be furnished and installed in complete accordance with Code seismic requirements.
- N. In case of difference between these specifications, codes, laws, industry standards, and/or utility company regulations the most stringent requirement shall govern.
- 1.05 EXAMINATION OF BIDDING DOCUMENTS
- A. Each bidder shall examine the bidding documents carefully, and not later than seven days prior to the date of receipt of bids, shall make written request to the Architect for interpretation or correction of any discrepancies, ambiguity, inconsistency, or error therein which he may discover. Any interpretation or correction will be issued as an addendum by the Architect. Only a written interpretation or correction by addendum shall be binding. No bidder shall rely upon interpretations or corrections given by any other method. If discrepancies, ambiguity, inconsistency, or error are not covered by addendum or written directive, Contractor shall include in their bid, labor materials and methods of construction resulting in higher cost. After

award of contract, no allowance or extra compensation will be made on behalf of the Contractor due to his failure to make the written requests as described above.

- B. In order to become familiar with the scope of the work involved, visit the existing site, before submitting bid, and carefully examine the existing conditions in order to have full knowledge and understanding of the conditions and restrictions affecting the performance of the work required. Include in bid all work which is reasonably inferred by the contract drawings and specifications, whether specifically shown or not, as a result of existing conditions, construction, irregularities and interferences which may affect work and is necessary for fully functioning system. No additional compensations will be considered for misunderstanding the conditions to be met.
- C. The person submitting the request will be responsible for its prompt delivery. Failure to so request clarification of any inadequacy, omission, or conflict will not relieve the Contractor of responsibility. The signing of the Contract will be considered as implicitly denoting that the Contractor has a thorough comprehension of full intent and scope of the working drawings and specifications.

1.06 BIDS AND SUBSTITUTIONS

- A. Materials, equipment or services listed by several identifying names are intended to be bidder's choice, and any of the listed names may be bid without soliciting prior acceptance. In all cases where more than one name is given in the specifications, the first named manufacturer's material, equipment or services shall be the basis of design which has been contemplated in coordination and production of the Contract Documents. Where equipment is noted in the drawings or on schedules in the drawings, the manufacturer and model number listed in the schedule shall be considered the basis of design and shall supercede listing order in the specification. Any changes, including spatial requirements, and costs required to accommodate materials or equipment other than the basis of design shall be the responsibility of the Contractor bidding other than basis of design equipment.
- B. If the Contractor wishes to submit a substitute to the named manufacturer(s) for any equipment, they shall submit in writing on Architect's Substitution Request form, prior to bid, stating the manufacturer's name, model number, and detailed product data. In all cases, if the substitute manufacturer is used, the Contractor shall bear all additional costs including, but not limited to, responsibility of coordination with all other trades, any changes incurred in plumbing, electrical, mechanical, general, etc., which result from equipment or material substitution.
- C. Where materials or equipment are specified by name, the proposed material or equipment must be identical to the specified material or equipment in all characteristics of quality, function and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture. Work performed or constructed with unapproved materials/equipment is at Contractor's risk, and any required correction of Work incorporating materials/equipment shall be at Contractor's sole cost and expense.
- D. Performance Specification of Products:
 - 1. Where any product is specified only by requirement to meet an industry standard or regulating body standard such as UL, AGA, AWWA, ANSI, etc. and the item proposed carries approval of that body, no prior acceptance by the Architect / Engineer is needed.

2. When any product or service is specified by requirement to meet a performance standard or is specified by a generic specification, (no manufacturers name listed) no prior acceptance by the Architect / Engineer is needed except as specifically called for in these specifications.
 - E. Approval by the Architect / Engineer of equipment other than the specified does not relieve Contractor of this Responsibility.
 - F. Acceptance
 1. In all instances, Contractor shall assume full responsibility for proof of equality of the stature to the equipment hereinafter specified. All data and information necessary for proof of equality, function and space requirements shall be prepared and accompany the submittal of the Substitution Request to the Architect / Engineer.
 2. Specified material and equipment shall be considered the basis of design, and while not specifically mentioned, characteristics such as material types, gauges, weights, appearance and space requirements of the basis of design materials and equipment must be met by any proposed substitutions.
 3. Action for substitutions specified herein will be given only after the receipt of formal Substitution Request accompanied by complete data showing performance over entire range, physical dimensions and material construction all specifically marked for the individual item in accordance with requirements for Submittals of Product Data.
 4. Where the substitution requires any changes in piping, electrical wiring, clear space for service requirement, venting, ducting, submit Coordination Drawings with the Substitution Request indicating changes required and conclusively coordinating changes required for the HVAC Division as well as changes required for all other Divisions. Contractor submitting the Substitution Request shall:
 - a. Be responsible to coordinate all Divisions and make all changes required to accommodate the Substitution.
 - b. Pay for all changes required of both the HVAC Division and all other Divisions to accommodate the Substitution.
 5. Approval of the Substitution Request by the Architect / Engineer does not relieve the Contractor of the above responsibilities. See General Conditions for method of notification of acceptance.
 - G. In the event the substituted material or equipment does not perform to meet the design intent, fit or meet quality standards, the Contractor shall provide the specified material or equipment and bear all costs to replace the substitute item(s).
- 1.07 PERMITS, FEES AND NOTICES
- A. Apply for and pay for all permits, fees, licenses and inspections for this Division of work.
 1. Do not include the cost of any "Plant Investment Fee" or "System Development Charge" for sewer and/or water charged by the City. This will be arranged for and paid for by the Owner.
 2. Do not include the cost of any "Gas Application Fee" charged by the Utility Company. This will be arranged and paid for by the Owner.
 - B. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.

1.08 PLANS AND SPECIFICATIONS

- A. The intention of the plans and specifications is to provide all piping, fixtures, and equipment. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Wherever the term "provide" is used, it shall mean "furnish and install".
- B. All plans and specifications including architectural, interiors, site, structural, electrical, plumbing and HVAC plans shall be examined by Contractor prior to submission of quotations to determine systems interface and conditions which could cause interference or deviations in equipment locations and routing. Errors or discrepancies on plans or in specifications shall be reported to the Architect/Engineer in writing and written instructions obtained for the discrepancy prior to submittal of bid to the Owner.
- C. All changes from the plans necessary to make the work conform to buildings as constructed and to fit work of other trades, or to conform to rules of all governing authorities and regulations, shall be met by each Contractor without extra cost to the Owner.
- D. Routing of piping and location of equipment and other devices are shown on plans in a diagrammatic manner for general guidance. Plans shall not be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings, and from the structure itself before fabricating any work. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect, or Engineer.
- E. Manufacturer's drawings and instructions shall be followed in all cases where the makers of devices and equipment furnish directions covering point not shown on the drawings or described in the specifications. Install all equipment in accordance with manufacturer's recommendations, unless approval is given in writing by the Engineer for deviation.
- F. Layout and installation of HVAC work shall be coordinated with the overall construction schedule of various trades to prevent delay in completion of the project. Complete drawings and specifications for the entire job shall be maintained and updated at the job site. Coordinate the HVAC work with and be responsible to the General Contractor for satisfactory progress of the work. Coordinate HVAC work with all other trades on the project without additional cost to the Owner.
- G. Priority of interpretation of discrepancies in Contract Documents shall be complimentary from specifications to drawings. Where discrepancies occur between various specifications, drawings and specifications or codes and standards, the most demanding requirement shall take precedence, except where written interpretation from the Architect/Engineer indicates otherwise.
- H. All work and materials covered by drawings and specifications shall be subject to review at any time by representatives of the Architect and Owner. If the Architect or Owner's agent finds any materials or installation that does not conform to these drawings and specifications, Contractor shall remove the material from the premises and correct the installation to the satisfaction of the agent.
- I. In acceptance or rejection of installed mechanical systems, no allowance will be made for lack of skill on the part of the installers.

1.09 SUBMITTALS

A. General

1. Submit under provisions of Division 01 and the requirements below.
2. The purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect / Engineer that the Contractor understands the design concept. Contract shall demonstrate their understanding by indicating which equipment and material they intend to furnish and install, and shall detail the fabrication and installation methods they intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and contract documents are discovered either prior to or after shop drawings and specifications shall control and shall be followed.
3. Review of Submittals is rendered as a service only and shall not be considered as a guarantee of measurements or of building conditions; nor shall it be construed as relieving the Contractor of basic responsibilities under their Contract. Architect / Engineer will check submittals only for conformance with the design concept of the project. Review shall not be construed as:
 - a. Permitting any departure from the contract requirements.
 - b. Relieving the Contractor of the responsibility for any error in details, dimensions or otherwise that may exist in the Shop Drawings.
 - c. Contractor agrees that shop drawing submittals processed by the Architect / Engineer are not change orders.
4. Submittal Schedule: Generate a Schedule of anticipated initial submittals for this Division and provide to General Contractor. Include in schedule specified durations time for review, submittal revision, resubmittal, and subsequent review as indicated in Division 01. Structure submittal schedule to allow for construction and delivery long lead and critical path items based on the overall project construction schedule. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet construction schedule, together with any special handling charges, shall be borne by the Contractor.

B. Shop Drawings

1. Proposed Product List: At the onset of Project's submittal phase, this Contractor shall submit a complete list of all material and equipment they propose to use in the installation. This list shall include all products specified in this Division and indicate manufacturer, catalog numbers and other identifying information. Architect / Engineer reserves the right to not review individual Product Data and Shop Drawing submittals until the Proposed Product List has been submitted and reviewed.
2. After review of the Proposed Product List by the Architect / Engineer, the Contractor shall submit Product Data and Shop Drawings including descriptive literature of the equipment to be provided under this contract. Drawings shall state capacities, sizes, etc., of all equipment and shall be certified.
3. The shop drawings shall be reviewed by the Contractor and stamped and signed certifying they have reviewed and found them to be 100% complete and accurate, prior to submission. Mark project name and location on each shop drawing, catalog cut and/or specification sheet along with Contractors signed stamp. Architect / Engineer reserves the right to reject shop drawings submitted without project name, location or stamp of Contractor's review.

4. Clearly mark each shop drawing, catalog cut and/or specification sheet to indicate those products and features which are intended to be furnished. Use highlights, arrows, underlines, circles and strikethroughs to identify exact features, options, capacities, characteristics and dimensions of equipment to be provided. Strike through information that does not apply to the intended product, options not intended to be included, and any manufacturer's disclaimers such as "Dimensions Subject to Change Without Notice." Options not specifically struck will be understood to be included. Architect / Engineer reserves the right to reject shop drawings not adequately marked in the above manner.
5. Review and approval of shop drawings shall not relieve the Contractor from the responsibility of furnishing equipment and materials of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents. Review and approval does not relieve the Contractor from responsibility for errors on the shop drawings. If the shop drawings deviate from the contract documents, Contractor shall advise the Architect / Engineer of such deviations in writing accompanying the shop drawings submittal, including the reasons for the deviations. Coordinate all required changes with the other trades affected. If the changes are occasioned by the Contractor, they shall pay any costs involved.

C. Architect / Engineer's Review of Submittals:

1. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect / Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect / Engineer in writing of such deviation at the time of submittal and the Architect / Engineer has given written approval of the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings Product Data, Samples or similar submittals by the Architect / Engineer's approval thereof.
2. Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.
3. The Architect / Engineer will review and approve or take other appropriate action upon contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect / Engineer's action will be taken with such reasonable promptness as to cause no delay in the Work of the Contractor or in the activities of the other Contractors, the Owner, General Contractor, or the Owner's Representative, while allowing sufficient time in the Architect / Engineer's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation of performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect / Engineer's review of the Contractor's submittals shall not relieve the Contractor of the obligations per the Contract Documents.

1.10 EXISTING UTILITIES

- A. The plans indicate the location, type and sizes of various utilities within the site where known. These utilities are indicated as accurately as possible. If utilities are encountered during construction, which are not shown on the drawings, ask for instructions from the Architect. Any relocation or remodeling required will then be directed by change order. Assume all responsibility for protection of all utilities, shown or not, and repair any damage caused by this construction at no extra charge to the Owner.
- B. Investigate with proper authorities for all existing water taps, etc. and make arrangements to pay for all removal charges in original bid.
- C. Owners of all underground utilities shall be notified prior to excavation so that they can locate and mark underground utilities.

1.11 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible, and in accordance with minimum required clearances as specified in codes and regulations.
- H. The word "concealed" as used in this specification refers to such spaces as pipe and duct chases, pipe and duct trenches, above plastered ceilings, in walls and buried where pipe and/or duct is inaccessible when building is complete. "Exposed" is intended to be within equipment rooms, unfinished areas, above "push up" ceilings, accessible pipe and duct tunnels.
- I. The term "furnish" means supply and deliver to Project, unless otherwise defined in greater detail. The term "install" is used to describe operations at Project, from inspecting and unloading, to completion in place, ready for intended use. The term "provide" means furnish and install, complete and ready for intended use, unless otherwise defined in greater detail.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Use only new materials, of the best quality of their respective kinds.
- B. All materials, in general, shall be Underwriter's Laboratories listed and labeled.

2.02 EQUIPMENT MANUFACTURER

- A. Equipment in the following categories shall be of one manufacturer or available through one manufacturer for each category to facilitate ease of maintenance for the Owner.
 - 1. Access Doors
 - 2. Motors (open drip-proof squirrel cage)
 - 3. HVAC Fixture Trim
 - 4. Pressure Gauges
 - 5. Starters, including Variable Frequency Drives
 - 6. Strainers
 - 7. Temperature Controls
 - 8. Thermometers
 - 9. Valves

PART 3 - EXECUTION

3.01 ENGINEERING BY CONTRACTOR

- A. The construction of this building requires the contractor to design several systems or subsystems. All such design shall be the completed responsibility of the contractor. Hangers, supports and seismic restraint systems and design details are hereby delegated to the contractor to design, detail, and submit with seal of Registered Professional Engineer for review by Architect / Engineer.

3.02 SAFETY AND MAINTENANCE OF WORK AREAS

- A. The Engineer has no contractual responsibility in connection with job site safety measures or precautions as related to means, methods, techniques, sequences or procedures. Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Architect/Engineer's observations of the Contractor's performance are not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site. Contractor shall be responsible for providing all such safety measures and shall consult with the Local, State or Federal Safety Inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist; or whether he is or is not in compliance with Safety Regulations.
- B. During the project, this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project

3.03 HANDLING AND STORAGE OF MATERIALS AND EQUIPMENT

- A. Provide for proper storage of all materials and equipment and assume responsibility for losses due to any cause. All storage shall be within the contact limit lines of the building site. Cover and store all equipment and materials out of elements; any rusted or weather damaged item shall not be used.
- B. It is recognized that space at the project for storage of materials and products is limited. Coordinate the deliveries of HVAC systems materials and products with the scheduling and sequencing of the work so that storage requirements at the project are minimized. In general, do not deliver individual items of equipment to the project substantially ahead of the time of installation. All materials shall be covered prior to installation and protected until final acceptance.

3.04 COORDINATION AND INSTALLATION OF THE WORK:

- A. COORDINATION AMONGST TRADES:
 - 1. This Contractor shall provide a qualified person during the construction phase of the shop drawing development that has the skills to convert the diagrammatic project drawings into composite assembly drawings in the CAD format determined by the Mechanical Contractor, for integration of systems into the combined master per floor coordination documents being assembled by the Mechanical Contractor. These coordination / fabrication drawings will conform to the performance criteria identified in the project documents and will fit into the 3 Dimensional allotted space for all systems. Where the piping dimensions, sizes and general arrangements of elements will require to be adjusted due to coordination of new or existing building structure, Architect's reflected ceiling plan and other trade's materials and or equipment space needs, qualified person will provide proposed recommendations of sizes, elevation changes, offsets, etc. for inclusion in a combined drawing(s) for the coordination meetings that will be reviewed by the Architect, Engineer, Owner and other trades to provide an overall acceptance of coordination per floor.
 - 2. The layout shown on the drawings is necessarily diagrammatic but shall be followed as closely as other work will permit. Changes from these drawings required to make this work conform to the building construction shall be made only with prior written approval of the Architect/Engineer. All proposed changes shall be shown on shop drawings. All measurements shall be verified by actual observation and all work shall fit in place meeting the approval of the Architect/Engineer.
 - 3. Provide openings required in new and existing construction that may be necessary. All patching and repairing shall be done by workmen competent in the trade required, at the expense of this Contractor. Arrange work so that minimum cutting will be required. All rubbish and excess materials involved in such cutting shall be promptly removed from the site and disposed of. Cutting through the floor or roof systems or load bearing walls shall be done only with the prior written approval of the Architect/Engineer so as to avoid damaging the structural system.
- B. SEQUENCING, SCHEDULING:
 - 1. Confer with the other contractors regarding the location and size of pipes, equipment, ducts, openings and special architectural treatments in order that there may be no interferences between the installation or the progress of the work of any contractor on the project.

2. In the case of interconnection of the work of two or more contractors, verify at the site or on shop drawings all dimensions relating to such work. All errors due to the failure to so verify any such dimensions shall be promptly rectified.
3. Access panels, in walls or ceilings, required (i.e., automatic or manual damper, fire or smoke damper, coil or control instrument mounted in a duct or pipe) shall be provided by the respective contractor and installed by workman competent in the trade required at the expense of this Contractor. Access panels are not required in areas where the ceiling system is lay-in tile; however, sufficient space must be available in and through the ceiling system to allow maintenance and adjustment of dampers, and cleaning of coils as necessary, or a suitable access panel shall be provided for that purpose. Access panels shall be approximately 24 inches by 24 inches wherever possible and shall be provided with flush trim and an allen-key operated camlock fastener. Submit manufacturer's product data to Architect for approval.
4. Items of equipment may be specified in the singular however, provide and install the number of items of equipment as required for a complete system.
5. Provide excavating, pumping, backfilling and compacting required, as shown on the drawings.
6. Equipment and devices which have factory prime coat or final surface finish shall be replaced, repaired or refinished if defective or damaged during installation.
7. Arrange all work so a minimum period of interruption or outages will occur in the temporary or permanent transfer of services as required for all electrical revisions. Not less than two (2) weeks notification to the Using Agency/Owner shall be required before approval will be granted for any disruption of services. The outage request shall include the extent of the work to be done, length of outage time required and the time at which the outage is to begin. No allowance will be made for extra payment as a result of scheduling "overtime" work necessary to perform before or after normal or regular working hours to accomplish the work intended.
8. Submit a "Sequence of Work Schedule" in respect to all temporary and permanent utility and service cutovers after final determination. This schedule shall be submitted for approval to the Architect/Engineer. The submittal shall designate priority order, service or utility affected, date of cutover, and time of day to start and finish.

C. MANUFACTURER'S INSTRUCTIONS

1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. All items which are a source of noise generation and/or mechanical vibration shall be installed with proper attenuation provisions including absorbers, isolators, or mufflers as required to prevent objectionable noises and vibrations.
4. If a conflict exists, notify the Architect/Engineer in writing and obtain instruction before proceeding with the work in question.

D. HOISTING AND MOVEMENT OF EQUIPMENT

1. This Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.
2. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.

3. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.
4. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
5. Where mechanical products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

E. CONCRETE

1. All poured in place concrete required for equipment furnished under this Division shall be furnished & installed by this Division in accordance with requirements specified under the Architectural Divisions of these Specifications.
2. Concrete pads shall be minimum 4 inch high and anchored to the floor with dowels.

F. CLEARANCES

1. Install piping and equipment:
 - a. Straight and true.
 - b. Aligned with other work.
 - c. Close to walls and overhead structure (allowing for insulation).
 - d. Concealed, where possible, in occupied spaces.
 - e. Out-of-the-way with maximum passageway and headroom remaining in each space.
 - f. Conceal all piping in finished areas of the building except where otherwise noted on the drawings.
2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:
 - a. 7'0" headroom in storage spaces.
 - b. 8'6" headroom in other spaces.
3. Do not obstruct windows, doors or other openings.
4. Give the right-of way to piping systems required to slope for drainage (over other service lines and ductwork).
5. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room and pitch of sloping pipes whether or not indicated on the drawings. Furnish and install all traps, air vents, sanitary vents, etc., as required to affect these offsets, transitions and changes in direction.

G. ACCESS AND ACCESS DOORS

1. Install all work to permit removal (without damage to other parts) of coils, heat exchanger bundles, boiler tubes, fan shafts and wheels, filters, belt guards, sheaves and drives, and all other parts which might require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit ready access to valves, traps, starters, motors, control components and to clear the openings of doors and of access panels. Furnish access panels for all mechanical equipment and valves requiring access in concealed locations for installation by contractor.
2. Provide shop drawings to the Architect and Engineer showing locations of all access panels.
3. Furnish access doors of type suitable to Architect and provide to General Contractor to construct into the building. Access doors should be provided in all locations where access is required.

4. Provide painted, steel (unless noted otherwise) access doors with key lock suitable for the surface in which they are installed and satisfactory to the Architect.
 - a. Plaster finish walls and ceilings: Recessed style.
 - b. Acoustical tile ceilings: Recessed type.
 - c. Drywall walls and ceilings: Flush panel.
 - d. Remodel Applications: Flanged flush panel.
 - e. Corrosive environments, including but not limited to, restrooms, locker rooms, pool equipment rooms, and natatoriums: Panel and frame shall be aluminum or stainless steel. All associated hardware and fasteners shall be stainless steel.
 - f. Panels in fire and/or smoke rated assemblies shall be listed for the application and carry the appropriate rating for the assembly in which they are installed.

3.05 SEISMIC ANCHORAGE AND BRACING

- A. All equipment and piping shall be braced, restrained, anchored or sway braced to resist a seismic event; as required by Chapter 16 of the 2006 International Building Code and ASCE 7-05. Refer to Structural Drawings for Design Spectral Response at Short Periods. Consider the building Occupancy as Category IV. Consider all piping, equipment, and systems installed under this Division as crucial for the continued operation of the facility after a seismic event and are thus assigned an $I_p = 1.5$ Importance Factor.
- B. Piping shall be installed per SMACNA, Seismic Restraint Manual, Guidelines for Mechanical Systems and Plumbing Piping Systems, and all code requirements. See Schedules and Details on Drawings.
- C. Contractor shall submit with equipment and piping shop drawings all required anchorage, bracing and restraints complete with calculations/details designed by a Registered Structural Engineer, and Engineers' Seal and Signature shall be affixed thereto.
 1. Contractor shall be responsible to obtain and provide all anchors, supports, etc. necessary for all code agency approvals.
 2. Piping may also be restrained by prefabricated supports; Midland Ross Corporation, Superstrut Universal seismic supports; Kin-Line Inc., seismic restraint system; B-Line seismic restraints; TOLCO seismic restraints; or any other pre-approved system recognized by the city/county, state codes; provide proof of compliance.

3.06 PROTECTION OF WORK AND PROPERTY

- A. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work of Owner's operation.
- B. Close all pipe openings with caps or plugs during installation. Cover all fixtures and equipment and protect against injury. At the final completion, clean all work and deliver in an unblemished condition, or refinish and repaint at the discretion of the Architect.
- C. Any equipment, duct or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Architect / Engineer's satisfaction.

- D. Initial fill of traps: Provide initial water seal fill for all waste p-traps, condensate traps, or similar traps.

3.07 PROTECTION OF POTABLE WATER SYSTEMS

- A. All temporary water connections shall be made with an approved back flow preventer.
- B. All hose bibbs shall have, as a minimum, a vacuum breaker to prevent back flow.
- C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.08 TEMPORARY HEAT, VENTILATION, AND AIR-CONDITIONING

- A. Temporary heat, ventilation, and air-conditioning (HVAC), if required for the construction activities, shall be furnished by the General Contractor. Use of the permanent HVAC system shall not be allowed without written authorization from the Engineer. In the event the permanent HVAC systems are desired to be used prior to substantial completion and final cleaning, the General Contractor shall meet all requirements of the Engineer's written authorization and shall pay all utility costs for operation of the HVAC systems until acceptance by the Owner.

3.09 ELECTRICAL EQUIPMENT AND WIRING FOR HVAC DIVISION

- A. Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule. (MD is Mechanical (HVAC) Division - ED is Electrical Division).

Type	Furnished Under	Set in Place by	Wired & Connected by
Equipment Motors and Thermal overloads, resistance heaters (C)	MD	MD	ED
Motor Controllers; magnetic starters, reduced voltage starters and overload relays.	MD	ED(A)	ED
Disconnect switches, fused or unfused, H.P. rated switches, thermal overload switches and fuses, manual operating switches.	ED(A)	ED(A)	ED
Push-button stations, pilot lights, multi-speed switches, float switches, thermostats, control relays, time clocks, control transformers, control panels, motor valves, damper motors, solenoid valves, EP and PE switches and interlocks	MD	MD(B)	MD(B)
120 volt power for Building Automation System (BAS) panels, fire protection and boiler controls	ED	ED	ED

3.10 Notes:

- A. If furnished as part of factory wired equipment, wiring and connections only by ED.
- B. If any of these devices carry the full load current to any motor or resistive element(s) they shall be connected by ED. Control devices carrying full load current furnished by MD and wired by

ED shall be located at the device being controlled, unless shown on drawings or mutual agreement is made between the contractors with no change in the contract price.

- C. Wiring from alarm contacts to alarm system by ED; all control function wiring by MD. Duct detectors furnished by ED, set in place by MD.

3.11 GENERAL NOTE:

- A. The above list does not attempt to include all components. All items necessary for a complete system shall be included in the base contract.
- B. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connectors.

3.12 FLUSHING, CLEANING & STERILIZING

- A. Intent: It is the intent of this specification to require that all work, including the inside of equipment, be left in a clean condition with all dust, grease, and construction debris removed.
 - 1. Piping and connection equipment to be left free of sediments, core sand, grease, etc.
 - 2. Clean all exposed surfaces of piping, ducts and hangers, etc., sufficiently to receive paint. Vacuum ducts as required for debris removal.
 - 3. Air systems shall not be operated without filters. Replace the filters or clean permanent type filters just prior to substantial completion. All air systems shall be furnished with one additional set of filters for owner replacement.
 - 4. Remove and clean all screens, interceptors, strainers, etc., in piping systems just prior to substantial completion.
 - 5. Clean and wipe dry all plumbing fixtures, exposed valves, faucets, and piping, etc. that are exposed just prior to substantial completion. Clean all equipment and fixtures per manufacturer's specifications to avoid scratching finished surfaces. Leave all plumbing fixtures ready to use.
 - 6. Clean interior and exterior of all air handling equipment of all construction debris. Clean exterior of all exposed ductwork just prior to substantial completion.
 - 7. Thoroughly clean all equipment room floors after completion of equipment, pipe and duct cleaning. A condition of final acceptance will be the cleanliness of all exposed systems, equipment, and equipment rooms.
- B. Before final connections are made in the piping systems, blow out all piping with air and then wash out with cleaning compounds. Then flush the system to remove of all foreign materials. Furnish all temporary connections, valves, etc, required for this purpose. Clean the boiler and chiller by the same procedure.
- C. Clean the boiler by the same procedure.
- D. After flushing, sterilize the domestic water system in accordance with Domestic Water Piping section.

3.13 TESTING

- A. Test all low pressure steam, condensate, heating water, snowmelt, condenser water, and chilled water piping at 150 psig hydrostatic pressure before connecting to unit.

- B. Test all high pressure steam and condensate, radiant panel (embedded in concrete) and anti-freeze piping at 200 psig hydro static pressure.
- C. Test all air, oil and gas piping under 60 psig air pressure.
- D. Test all refrigeration piping under 150 psig pressure using oil pumped, dry nitrogen and tapping of joints if there is any loss of pressure, soap each joint to find leaks. Charge with 10 psig refrigerant and test with halide torch or electronic leak detector. Evacuate using vacuum pump to 500 microns and purge twice with oil pumped, dry nitrogen.
- E. Test all high velocity ductwork from supply fan to boxes before ducts are concealed and before boxes are connected. All openings shall be capped off and partial sections of the duct to be tested using a fan capable of building 8" S.P. Use U-gauge manometer to test S.P. Repair all audible and visible leaks using smoke in ducts.
- F. All tests must be done to the satisfaction of the local authorities having jurisdiction, before covering.
- G. All hydrostatic tests to be held for a minimum of six hours without loss of pressure. Air tests to be held for a minimum of two hours without loss of pressure.
- H. Furnish all instruments required for testing.

3.14 EQUIPMENT START UP AND PLACING IN OPERATION

- A. Clean all ducts, pipes, equipment, controls etc., of plaster and other foreign debris.
- B. Before final acceptance, clean or replace all strainers, oil or grease all bearings and clean out all drains. Clean and recoat all permanent filters, replace throwaway type filters with new filters.
- C. The systems shall be put into operation.
 - 1. The Contractor shall verify that all controls are set to meet operating conditions specified.
 - a. Example: Boiler operating and limit controls set where specified.
 - 2. The contractor shall verify that all pieces of equipment are operable and that all sequences of control are being met.
 - 3. The contractor to adjust settings through 1st year as required by MECHANICAL ENGINEER.
- D. All packaged HVAC equipment shall be started by the manufacturer or under the manufacturer's supervision. Start-up data shall be recorded in logs. Copies of start-up logs shall be forwarded to the Engineer and included in Operation and Maintenance manuals.

3.15 CLEANING

- A. Immediately prior to inspection for Substantial Completion, remove any remaining waste materials and rubbish from mechanical and electrical rooms. Remove protective coating, barriers and other protective devices, temporary work, and surplus materials.
- B. Leave mechanical rooms and similar unfinished spaces "Broom Clean." Dust equipment, ducts, pipes, and other mechanical and electrical work in mechanical rooms and similar unfinished spaces. Remove construction dirt and debris from interior of equipment, panels, disconnects, ductwork, etc. thoroughly in accordance with manufacturer's instructions.

- C. Upon completion of the contract all remaining materials and rubbish shall be removed from the building and premises and the work areas shall be left clean and free from stains, mortar, paint spots, etc.
- D. Upon completion of the work, put systems into service maintaining responsibility for the equipment during all testing operations including the lubricating and turning on and off of such apparatus

3.16 CLOSEOUT SUBMITTALS

A. OPERATION AND MAINTENANCE INSTRUCTIONS

- 1. Books of Operating and Maintenance Manuals shall be delivered to the Owner's authorized representative and the Owner instructed as to their use and the equipment involved.
- 2. Thirty (30) days Prior to Substantial Completion, submit operating and maintenance manuals for equipment to Engineer for approval. Assemble manuals into white, 3-ring binders. Insert laminated cover sheets, identifying each binder on the front and spine with all necessary information so that all volumes appear uniform and orderly (i.e. Project Name, Owner Project Number, Contractor/Architect/Engineer Information, Volume Number, General Contents Description such as Mechanical, Electrical, etc.)
- 3. Provide comprehensive table of contents indicating the contents of all volumes in each set. Organize and tab documents in an orderly sequence, based on the table of contents of the project manual. Within each section, organize alphabetically by system or subsystem. Include a section in the directory for each of the following: list of documents, list of systems, and list of equipment.
- 4. Include copy of each submittal, including Architect / Engineer's review comments, and subsequent resubmittals for record purposes, indicating the actual product installed. Include significant changes in the product delivered to project site and changes in manufacturer's written instructions for installation.
- 5. Provide organized warranty section in the lead binder (Contractor's option to provide separate binder.) Organize warranty documents into an orderly sequence in separate binder, based on the table of contents of the project manual. A copy of each warranty shall also be provided in the respective equipment section.
- 6. Provide organized equipment failure emergency section in the lead binder (Contractor's option to provide separate binder.) Organize into separate sections for each type of emergency and include all necessary steps for safe equipment shut-down and containment. Also, include all necessary contractor and vendor contact information including 24-hour call numbers.
- 7. Provide comprehensive contact list in the lead binder including contractor and subcontractor's names, addresses, telephone and contact person for Owner's use.
- 8. Include equipment start up logs for all equipment required to be checked out and initially started under manufacturer's supervision.
- 9. Provide manufacturer's complete data sheets including assembly drawings, spare parts lists, wiring diagrams, mechanical diagrams, installation diagrams, and instructions. Identify equipment in manual and cross-reference by including serial number of actual components.
- 10. In addition to Manufacturer's maintenance documentation, provide separate schedules for preventative and routine maintenance and service with standard time allotment. Include

service and lubrication requirements and list of required lubricants for equipment, application methods and frequencies.

11. Provide Preventative Maintenance (PM) schedule for checking all items such as belt drives, safety controls, motor running load amps, oil, refrigerant and grease charges. Include cleaning schedule of all strainers, traps, coils, tubes, etc.
12. Include record of spare parts provided including signature of Owner's representative showing acceptance of parts. Provide list of additional items recommended to be stocked as spare parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and including local sources of maintenance materials and related services.
13. Provide test reports from manufacturer start-up indicating systems to be operating properly, including TAB reports, thermographics surveys, etc.
14. Provide electronic copy of final operation and maintenance manuals in full color pdf format on CD/DVD. All files shall clearly indicate specific information related to actual products installed. File structure and naming shall be "user-friendly" and organized in a manner similar to the hard copy binders such that it may be intuitively navigated by users.
15. Approval will not be given for final payment until the tests, balancing and operating instruction portions have been completed.

B. AS-BUILT DRAWINGS

1. During the process of the work, maintain an accurate record of the installation of the mechanical systems.
2. At the completion of the Work, Engineer shall furnish Contractor with a complete set of the latest revised record drawings in reproducible form, and Contractor shall indicate thereon all as-built changes and such additional details necessary or appropriate to provide a complete reference document for use by Engineer. If variations and details cannot be shown clearly thereon, the Contractor shall prepare supplemental drawings adequate to impart the information. These additional drawings shall also be in reproducible form. The foregoing drawings collectively shall constitute the "As-Built" drawings for the Work.
3. All indications on "As-Built" drawings shall be executed in a legible manner at Contractor's cost, using methods and legend presentations compatible with the overall scheme of the record Drawings with respect to scale, drawing sheet sizes and sequential indexing. All changes shall be marked clearly in red and clouded.
4. Engineer shall review Contractor's "As-Built" drawings and notify Contractor of observed discrepancies or deviations. Contractor shall promptly correct and resubmit revised drawings for Engineer review. Completed "As-Built" drawings shall be delivered to Owner through Architect.

C. DEMONSTRATION AND TRAINING

1. Refer to Division 01 for additional requirements regarding Demonstration, Training, and O&M Manuals submittals.
2. Prepare and submit operating instructions, as required by Specification Sections, and instruct Owner's personnel in use and maintenance of operating equipment. Explain use operation of each system to the Owner's designated representative(s). Explain use of the O&M manuals in operating and maintaining the systems.
3. After installation is complete, schedule to meet and instruct Owner's designated personnel in use, operation, care, and cleaning of equipment. Demonstrate that each

system operates properly. Instructions shall be given only by qualified personnel, thoroughly familiar with use and maintenance of equipment.

4. Notify the Engineer in writing a minimum of 72 hours in advance of any scheduled Owner equipment training. Following all training, provide record of Owner training including the type of training, who conducted the training, and list of attendees. Include copy in each set of O&M manuals.
5. Owner training sessions shall be video recorded to DVD media. DVD's shall be clearly labeled indicating content of equipment covered by training, and copies provided as follows: one (1) copy to the Owner, one (1) copy to the Engineer, and one (1) copy shall be included in each set of O&M manuals.

D. WARRANTY

1. Guarantee all work including labor, material and equipment for this project for a period of one year from date of acceptance by Using Agency/Owner. Repair or replace any work found defective without cost to the Owner during the warranty period.
2. All materials and equipment shall be new unless otherwise specified.
3. Guarantee all workmanship, materials and equipment and replace any found defective without cost to the Owner, for one year after final acceptance, as defined in General Conditions.
4. Each warranty for longer than the one year described above (that comes with equipment used on the job) shall be passed on to the owner with dates of start and end of the warranty.

END OF SECTION 23 0010

SECTION 23 0116 - DEMOLITION OF 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 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of the HVAC systems including
 - a. Ductwork
 - b. Piping
 - c. Equipment
 - 2. Abandoning in-place below-grade construction.
 - 3. Disconnecting, capping or sealing, and abandoning in-place site utilities.
 - 4. Salvage of existing items for reuse or recycling by Owner.
- B. Related Sections:
 - 1. Section 011000 "Summary" for use of the premises and phasing requirements.
 - 2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
 - 3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
 - 4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

1.03 DEFINITIONS

- A. Abandon In-Place: Disconnect existing component from service and label as abandoned, but do not remove. Distribution systems and networks such as piping and ductwork that are abandoned in place shall be labeled abandoned at intervals specified in Division 23 Section "Identification for HVAC".
- B. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
- C. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.
- D. Remove and Reinstall: Detach items from existing construction, clean, prepare for reuse, and reinstall where indicated.

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

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated in this section or in the drawings, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified refrigerant recovery technician.
- B. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for infection control measures, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Building Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 3233 "Photographic Documentation." Submit before the Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.06 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.07 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project Site.
 - 1. Inspect and discuss condition of construction to be demolished.
 - 2. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review and finalize protection requirements.
 - 4. Review procedures for noise and infection control measures.
 - 5. Review procedures for protection of adjacent buildings.
 - 6. Review items to be salvaged and returned to Owner.

1.08 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to demolition area. Conduct demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with HVAC systems demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.09 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations. Comply with Section 013233 "Photographic Documentation."
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.02 PREPARATION

- A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
- B. Existing Services/Systems: Locate, identify, disconnect, and seal or cap off indicated systems serving areas to be demolished.
 - 1. Arrange shut off of systems/service with Owner.
 - 2. If systems/services are required to be removed, relocated, or abandoned that will affect adjacent occupied/operational portions of the building(s), then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 - 3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
- C. Existing Utilities: See plumbing and electrical Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- D. Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.

3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 - 1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Label entire extents of system abandoned in place in accordance with Section 23 0553 "Identification".
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material. Label entire extents of system abandoned in place in accordance with Section 23 0553 "Identification for HVAC".
- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.04 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exit access from existing buildings.
- B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
 - 1. Do not interrupt existing utilities serving operating facilities unless authorized in writing by Owner.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.
 - a. Provide at least 10 days notice to occupants of affected buildings if shutdown of service is required during changeover.

- C. Temporary Protection: Erect temporary barriers to maintain pressure differentials necessary to meet the requirements of the Infection Control plan as required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."
 - 1. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
 - 2. Provide HEPA filtered exhaust of the demolition area to maintain airflow direction across the temporary barrier from clean portions of the building to areas of demolition and construction activity.
- D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.05 DEMOLITION, GENERAL

- A. General: Demolish indicated systems completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and for at least 8 hours, or duration required by Owner and Fire Marshal, after flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

3.06 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of HVAC systems systematically, from lower to higher level. Complete HVAC systems demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

- C. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.
- D. Below-Grade Construction: Demolish HVAC construction in foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet outside footprint indicated for new construction. Abandon below-grade construction outside this area.
- E. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
- F. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside footprint indicated for new construction. Abandon utilities outside this area.
 - 1. Fill abandoned utility structures with satisfactory soil materials according to backfill requirements in Section 312000 "Earth Moving."
 - 2. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 - 3. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.
- G. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
 - 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 - 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.07 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.
- B. Repair fireproofing where hangers and supports have been removed.
- C. Patch holes and openings in walls, floors, ceilings and structure created by removal of piping and ductwork.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3.09 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.10 SELECTIVE DEMOLITION SCHEDULE

- A. Existing Items to be Removed: All ductwork, piping and equipment as indicated in drawings.
- B. Existing Items to be Removed and Salvaged: Items of monetary value to the Owner as follows:
 - 1. Plumbing fixtures.
 - 2. Mechanical equipment of salvage value, including unit heaters, control valves, pumps, boilers, chillers, etc.
- C. Existing systems to be Abandoned In-Place: Specifically noted on drawings. Typically limited to distribution ductwork and piping located in portions of the building where removal is not economically viable. Label systems as abandoned at intervals specified in Division 23 Section "Identification for HVAC".
- D. Existing items to Remove and Reinstall: Specifically noted in drawings.
- E. Existing systems/services and items to Remain: All system not specifically noted as removed, demolished, or abandoned in place shall be considered existing to remain.

END OF SECTION 23 0116

SECTION 23 0130 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 01 Specification Section "Alternates" - Provide deduct alternate to not perform cleaning of existing duct systems in accordance with this section.

1.02 SUMMARY

- A. Section includes cleaning of the following existing HVAC air-distribution equipment, ducts, plenums, and system components:
 - 1. AHU-1 and associated ductwork which is being reused as part of new work.
 - 2. AHU-2 and associated dutwork which is being reused as part of new work.

1.03 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.

1.05 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. Cleaning Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.03 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Systems and Components to Be Cleaned:
 - 1. Ductwork:
 - a. Supply-air ducts, including turning vanes, to the air-handling unit.
 - b. Return-air ducts to the air-handling unit.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
 - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.

2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
 - F. Control odors and mist vapors during the cleaning and restoration process.
 - G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
 - H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
 - I. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
 1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 3. Clean evaporator coils, reheat coils, and other airstream components.
 - J. Duct Systems:
 1. Create service openings in the HVAC system as necessary to accommodate cleaning.
 2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - K. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
 - L. Mechanical Cleaning Methodology:
 1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
- 3.04 CLEANLINESS VERIFICATION
- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.

- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
 - 1. Perform surface comparison testing or NADCA vacuum test.
- E. Prepare a written cleanliness verification report. At a minimum, include the following:
 - 1. Written documentation of the success of the cleaning.
 - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 - 3. Surface comparison test results if required.
 - 4. Gravimetric analysis (nonporous surfaces only).
 - 5. System areas found to be damaged.

3.05 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Section 23 3113 "Metal Ducts." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 23 3113 "Metal Ducts."
- D. Replace damaged insulation according to Section 23 0713 "Duct Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Section 23 3116 "Nonmetal Ducts."

END OF SECTION 23 0130.51

SECTION 23 0513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections
 - 1.

1.02 SUMMARY

- A. This section includes:
 - 1. Requirements for general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Related Sections:
 - 1. Section 230010 - HVAC General Provisions
 - 2. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
 - 3. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturer's Association, Inc.; 1990 (Reapproved 2000)
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
- C. NEMA MG 1 - Motors and Generators; National Electronic Manufacturers Association; 2007.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2011.

1.04 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication and wiring instructions.

- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Conform to NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather, moisture, and construction debris by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

1.08 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Comply with NEMA MG 1, Design B for centrifugal fans blowers, pumps and compressors.
- B. Electrical Service:
 - 1. Motors smaller than 1/2 HP: 115 volts, single phase, 60 Hz.
 - 2. Motors 1/2 horsepower and larger: 208 or 480 volts, three phase, 60 Hz.
- C. Motors 3/4 horsepower and larger, or motors used in outdoor application (regardless of horsepower) shall be three phase, 60 Hertz.
 - 1. Motors configured in duplex applications shall have an individual electrical circuit to each motor.
 - 2. Motor starter coils and control circuits shall be powered by 120 volt control transformers located within the motor starter enclosure. Refer to Division 26 Section "Enclosed Controllers".
- D. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Motors shall be of cast iron construction.

3. Design for continuous operation in 104 deg F (40 deg C) environment.
 4. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- E. Duty: Continuous duty at ambient temperature of 86°F and at altitude of 6600 feet above sea level.
- F. Maximum load factor: Select motors with maximum ratio of brake horsepower (BHP) to nameplate horsepower not exceeding 0.8.
- G. 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.
- H. All motors furnished shall be the manufacturer's premium efficiency design. The nominal efficiency and the minimum guaranteed efficiency shall be stamped on the nameplate of the motor. All efficiency testing and labeling shall be done in accordance with the NEMA MG 1 standard.
- I. All three phase motors shall be "Inverter Approved" or "VFD Approved" and stamped as such on the nameplate of the motor.
- J. Explosion-proof motors shall be UL approved and labeled for hazard classification, with over temperature protection.
- K. Visible nameplates must be stainless steel, indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, and efficiency.
- L. Wiring Terminations:
1. Motor leads shall be stranded copper and shall be permanently identified and brought out into the motor terminal box through a neoprene gasket. Provide conduit opening suitable for locknut type connector. Include UL listed ground lug in terminal enclosure.
 2. For fractional horsepower motors where connection is made directly, provide conduit opening suitable for locknut type fitting in end frame.
- M. All motors that are used with VFDs shall have grounding brushes on the shaft of the motor. The terminal strip provided shall be tied to the building ground. Acceptable products: AEGIS SGR.
- 2.02 POLYPHASE MOTORS
- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Multispeed Motors: Separate winding for each speed.
- C. Rotor: Random-wound, squirrel cage.
- D. Starting Torque: Between 1 and 1-1/2 times full load torque.
- E. Starting Current: Six times full load current.

- F. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- G. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- H. Bearings: Grease lubricated, anti-friction ball bearings with housings equipped with provision for relubrication, rated for minimum ABMA STD 9, L-10 life for 100,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- I. Sound Power Levels: To NEMA MG 1.
- J. Temperature Rise: Class F.
- K. Insulation: Class F or better.
- L. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- M. Motors shall be 1800 rpm unless indicated otherwise. Enclosures shall be totally enclosed unless noted otherwise. Motors rated two horsepower and larger shall be fan cooled, premium efficiency design.
- N. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- O. Motor Frames: NEMA Standard T-Frames. Stator frame and end brackets shall be a minimum of grade 25 cast iron construction.
- P. Other Frame designation (e.g "T" Frame) motor plate rating shall be selected such that the brake horsepower of the equipment to be driven, through the full range of operating conditions, not including the service factor in the motor rating, does not exceed 80 percent of the name plate rating.
- Q. "U" frame motor nameplate rating shall not be less than the brake horsepower of equipment to be driven, through the full range of operating conditions, not including service factor in the motor rating.
- R. Thermistor System (Motor Frame Sizes 254T and Larger): Three PC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor stator.
- S. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and stator surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- T. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- U. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.03 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers (VFDs): Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.04 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp and less than 5 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor (PSC).
 - 2. Electrically commutated motor (ECM).
 - 3. Capacitor start, capacitor run (CS/CR).
- B. Multispeed Motors: Variable-torque, ECM.
- C. Split phase motors shall have the following characteristics:
 - 1. Starting torque: Less than 150 percent of full load torque.
 - 2. Starting current: Up to seven times full load current.
 - 3. Breakdown torque: Approximately 200 percent of full load torque.
 - 4. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- D. Capacitor start motors shall have the following characteristics:
 - 1. Starting torque: Three times full load torque.
 - 2. Starting current: Less than five times full load current.
 - 3. Pull-up torque: Up to 350 percent of full load torque.
 - 4. Breakdown torque: Approximately 250 percent of full load torque.
 - 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor.
- G. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

- H. Motors 1/20 HP and Smaller: Shaded-pole type.
- I. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Single phase motors for shaft mounted fans and blowers: Permanent split capacitor type.
- B. Three phase motors for exterior mounted fans.
- C. Motors located in exterior locations: Totally closed type.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.03 MOTOR DYNAMIC BALANCING

- A. Perform dynamic balancing and test motors for vibration after manufacture. Self excite vibration velocity of motor shall not exceed 0.157/0.06 inches per second at the bearing caps.

3.04 START UP

- A. Inspect, test and start each motor and align with a dial indicator to 0.002"

3.05 SCHEDULE

- A. NEMA Open Motor Service Factors.
 - 1. 1/6 - 1/3 HP: 1800 rpm: 1.35
 - 2. 1/2 HP: 1800 rpm: 1.25
 - 3. 3/4 HP: 1800 rpm: 1.25
 - 4. 1 HP: 1800 rpm: 1.15
 - 5. 1.5 - 150 HP: 1800 rpm: 1.15

END OF SECTION 23 0513

SECTION 23 0514 - VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. This section includes:
 - 1. Perform all Work required to provide and install a complete variable frequency motor drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.
 - 2. The drive manufacturer shall supply the drive and all necessary controls as specified.
- B. Related Sections
 - 1. Section 230920 - Control Systems
 - 2. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
 - 3. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. Standard 519, IEEE Guide for Harmonic Content and Control.
 - 2. ANSI/UL Standard UL508C, Underwriter's Laboratories.
 - 3. ICS 7.0, AC Adjustable Speed Drives, National Electrical Manufacturer's Association (NEMA).
 - 4. IEC 16800 Parts 1 and 2.

1.04 QUALITY ASSURANCE

- A. Company specializing in manufacturing the products specified in this Section with minimum three (3) years experience.

- B. VFD and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses are not acceptable.
- C. VFD and options shall be tested to ANSI/UL Standard 508 and listed by a nationally recognized testing agency such as UL or ETL.
- D. VFD and options shall comply with applicable requirements of the latest Standards of ANSI/UL, IEEE, and the NEC.

1.05 SUBMITTALS

- A. Product Data:
 - 1. Submit product data for components and accessories.
 - 2. All VFD's for this Project shall be supplied by one manufacturer.
 - 3. Submit Shop Drawings indicating outline dimensions, enclosure construction, lifting and supporting points, electrical one-line diagram, equipment electrical ratings, noise levels (including driven equipment) and total harmonic distortion (voltage and current).
 - 4. Manufacturer shall provide terminal block to terminal block wiring diagrams coordinated with the Owner to provide a complete and functional operating system. Furnish detailed Drawings showing construction, dimensions, wiring diagrams, and installation procedures for Engineer's approval.
- B. Operation and Maintenance Data:
 - 1. Submit manufacturer's written installation instructions.
 - 2. Submit training outline.
 - 3. Furnish harmonic analysis verifying compliance with specified distortion levels.
 - 4. Furnish a list of recommended spare parts.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01 and Division 20.
- B. Accept products on Site in factory-fabricated protective container with factory installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.07 EXTRA MATERIALS

- A. Submit two insulated-handle tools designed for pulling fuses in accordance with ANSI/IEEE C37.46.
- B. Refer to Section 262813 for fuse requirements.

1.08 WARRANTY

- A. VFD shall be unconditionally warranted by the manufacturer for two (2) years from the date of Substantial Completion, not to exceed 30 months from date of shipment.

- B. Warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses, and verbal or written correspondence with the VFD manufacturer or VFD manufacturer's representatives. Include correspondence which might be incidental to the proper installation and operation of the equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Furnish complete VFD controllers that convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
- C. Contractor shall check equipment schedules on the Contract Drawings to determine if the VFD "bypass" switch option is required to allow the motor to run if the controller malfunctions. If the "bypass" switch option is not required, articles and statements in this section do not apply, and the Contractor shall provide one spare VFD for each equivalent horsepower motor or equipment power load indicated on the Contract Drawings.
- D. VFD manufacturer shall verify compatibility of motor furnished on equipment. One controller shall control the speed of one motor with the exception being a wall fan technology system.
- E. VFD shall convert 3 phase, 60 Hz utility power to adjustable voltage and frequency, 3 phase AC power for stepless motor speed control from 10 percent to 100 percent of the motor's 60 Hz speed. Input voltage characteristics are 480 volts, 3 phase, 60 Hz.

- F. VFD shall include a converter section. The converter section shall convert fixed frequency and voltage AC utility power to a variable DC voltage. VFD's that use silicon controlled rectifiers in the converter bridge shall also include 5 percent reactors. Isolation transformers are not acceptable in lieu of line reactors.
- G. VFD shall include an inverter section. The inverter section shall invert the variable DC voltage into a PWM wave form; adjustable voltage and frequency output for stepless motor speed control.
- H. Individual or simultaneous operation of VFD's shall not add more than 5 percent total harmonic voltage distortion and no more than 5 percent total harmonic current distortion (per IEEE 516-1992) to the normal bus.
 - 1. VFD manufacturer shall perform harmonic analysis based on the electrical one-line diagram.
 - 2. The VFD manufacturer shall provide calculations specific to this installation, showing total harmonic voltage distortion is less than 5 percent.
 - 3. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE Standard 519. All VFD's shall include a minimum of 5 percent impedance reactors, no exceptions.
- I. VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5 percent impedance reactors.
- J. Alternate Harmonics Specification:
 - 1. Input line reactors and DC Bus filtered chokes (factory installed and wired in the drive enclosure) shall be provided to allow reliable operation on a typical commercial power distribution system and to minimize harmonics reflected onto the input line.
 - a. Shall not interfere with computer and other electronic systems in the building.
 - b. If not inherently protected, provide a suitable isolation transformer.
 - c. The system shall not produce spikes on the incoming line.
 - 2. Any inverter that generates sufficient electrical line noise to interfere with operation of sensitive building equipment shall be field modified or replaced by the inverter supplier at no additional cost to the Owner.
- K. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product Standard EN 61800-3 for the First Environment restricted level.
- L. Low voltage logic and 115V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.
- M. VFD shall include a power ride-through feature to allow continuous operation up to a three-cycle line loss.
- N. Two independently adjustable accel and decel ramps with 1 to 1800 seconds adjustable time ramps. Extended time periods are also acceptable.
- O. VFD shall have full function output current limit adjustable from 10 to 100 percent. At the factory with compatible motor, provide at least three lock-out ranges (50 rpm maximum each), two of which can be used to correct any run test problems.

- P. Components shall be pretested and complete VFD shall have full burn-in under full load for a minimum of 12 hours. Provide at least three lockout ranges (50 rpm maximum), two of which can be used to correct run test problems.
- Q. Ambient noise generated by the VFD shall be limited to an amount equal to the system noise level as designated by the latest ASHRAE noise level guidelines for such equipment at each octave band. Noise level criteria at different octave bands and mid-frequencies shall be furnished with the submittal data.
- R. VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

2.03 MANUFACTURERS

- A. Danfoss Graham.
- B. ABB.
- C. Yaskawa Electric.

2.04 ENCLOSURE

- A. VFD shall be enclosed in a UL Listed Type 12 enclosure. Enclosure shall be UL listed as a plenum rated VFD. The VFD tolerated voltage window shall allow operation from a line of +30 percent nominal, and -35 percent nominal voltage as a minimum.
- B. Environmental operating conditions: 0 to 40 degrees C continuous. VFD's that can operate at 40 degrees C intermittently (during a 24-hour period) are not acceptable and must be oversized. Altitude from 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing. VFD's without these ratings are not acceptable.
- C. The following operator controls shall be located on the front of the enclosure:
 - 1. Bypass Hand-Off-Auto.
 - 2. Drive mode selector.
 - 3. Bypass mode selector.
 - 4. Bypass fault reset.
 - 5. Provide the following indicating lights (LED type). In addition, provide test mode or push to test feature:
 - a. Power-on (ready).
 - b. Run enable (safeties) open.
 - c. Drive mode select damper opening.
 - d. Bypass mode selected.
 - e. Drive running.
 - f. Bypass running.
 - g. Drive fault.
 - h. Bypass fault.
 - i. Bypass H-O-A mode.
 - j. Automatic transfer to bypass selected.
 - k. Safety open.
 - l. Damper opening.

- m. Damper end-switch made.
 - 6. Provide the following relay (form C) outputs from the bypass:
 - a. System started.
 - b. System running.
 - c. Bypass overttide enabled.
 - d. Drive Fault.
 - e. Bypass fault (motor overload or underload-broken belt).
 - f. Bypass H-O-A position.
 - D. Digital inputs for the system shall accept 24V or 115VAC (selectable).
 - E. Customer Interlock Terminal Strip: Provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in fireman's override 2). The remote start/stop contact shall operate in VFD mode.
 - F. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required:
 - 1. The first mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
 - 2. The second mode operates as the first, but will also defeat the overload and singe-phase protection for bypass and ignore all keypad and digital inputs t the system 9run until destruction).
 - G. Include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
 - H. Include Class 20 or 30 (selectable) electronic motor overload protection.
- 2.05 BYPASS
- A. Furnish where indicated on the Drawings, a complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
 - B. Bypass to be furnished, built, and mounted by the VFD manufacturer.
 - C. Provide an internal switch to select manual or automatic bypass.
 - D. Provide an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.
 - E. Door interlocked, padlockable disconnect that will disconnect all input power from the drive and all internally mounted options.
 - F. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit

protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. The following contactor bypass schemes are not acceptable.

1. Door interlocked main input disconnect switch.
2. Power on light.
3. "Drive-off-bypass" manual mode selector switch.

- G. The bypass shall incorporate an internally sourced power supply and shall not require an external power source.

2.06 DISPLAY / KEYPAD

- A. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three (3) operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output frequency.
 2. Motor speed (RPM, percent, or engineering units).
 3. Motor current.
 4. Calculated motor torque.
 5. Calculated motor power (kW).
 6. DC bus voltage.
 7. Output voltage.
- B. Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall use the following assistants:
1. Start-up assistants.
 2. Parameter assistants.
 3. Maintenance assistant.
 4. Troubleshooting assistant.
- C. VFD shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. Keypad shall be removable, capable of remote mounting and shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.
- D. Keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
- E. Provide a built-in time clock with battery back-up in the VFD keypad. The time clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The time clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

2.07 SERIAL COMMUNICATION

- A. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. [Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of noncertified protocols is not allowed.
- B. VFD shall be provided with protocol information specific to the selected BAS Provider and shall be pre-configured at the factory to provide automatic communications without the need for field programming.
- C. VFD shall continue to provide serial communications regardless of how inverter is being controlled ("manual" mode via keypad, "automatic" mode via BAS, or "stopped" mode via either keypad or automatic BAS start/stop signal).
- D. Serial communications capabilities shall include, but not be limited to:
 - 1. Run/stop control speed set adjustment.
 - 2. Proportional/integral or PID control adjustments.
 - 3. Current limit.
 - 4. Accel/decel time adjustments.
- E. VFD shall have the capability of allowing the BAS to monitor the following feedback signals:
 - 1. Process variable.
 - 2. Output speed/frequency.
 - 3. Current.
 - 4. Torque.
 - 5. Power (kW).
 - 6. Operating hours.
 - 7. Kilowatt hours (kWh).
 - 8. Relay outputs.
 - 9. Diagnostic warning and fault information.
- F. VFD shall allow the BAS to control the drive's digital and analog outputs and monitor all drive digital and analog inputs via the serial interface.
- G. VFD shall be capable of providing the BAS with status signals for bypass operation and external safety trips via serial interface.

2.08 SYSTEM OPERATION

- A. Selector switch in the "off" position: controller run circuit shall be open and the system shall not operate.
- B. Selector switch in the "manual" position: motor speed shall be controlled by the manual speed potentiometer.
- C. Selector switch in the "auto" position: operation shall be via input 0 to 10 VDC or 4-20 mA signal with strategy output speed proportional to the input signal. If required into the controls

strategy, VFD manufacturer shall furnish a pressure transducer mounted in the drive enclosure to convert a 3 to 15 psi pressure signal to a 0 to 10 VDC signal or 4-20 mA signal.

2.09 HARMONIC MITIGATION

- A. The engineer has completed a preliminary harmonic analysis showing that all drives below 15 HP shall be 6 pulse drives with swinging chokes and all drives 25 HP and above shall be Ultra Low Harmonic designs ~~with an integral active front end~~. Drives with passive harmonic filters, 12 pulse, and 18 pulse drives shall not be acceptable. ~~Compliance to IEEE 519 does not relieve the vendor from the requirement to provide active front end drives, as specified above.~~

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that surfaces are ready to receive Work.
- B. Verify that field measurements are as shown on Shop Drawings and as instructed by manufacturer.
- C. Verify that required utilities are available, in the proper location, and ready for use.

3.02 HARMONIC ANALYSIS

- A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze designated operating scenarios, including recommendations for VFD input filtering to limit TDD and THD(V) at each VFD to specified levels.
- B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.03 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. 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.
- C. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) 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 Section 260529 "Hangers and Supports for Electrical Systems."
- D. Floor-Mounting Controllers: Install VFDs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems.
- F. All installation shall be in accordance with manufacturer's published recommendations.
- G. Power wiring shall be completed by the Electrical Contractor in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- I. Install fuses in each fusible-switch VFD
- J. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- K. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

3.04 IDENTIFICATION

- A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems.
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each VFD with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.05 CONTROL WIRE INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
1. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors

3.06 TESTING

- A. Manufacturer shall provide a factory trained technician to inspect, test and start-up the VFD and associated equipment and place the VFD into operation.
- B. A harmonic test verifying the distortion level shall be included as part of Start-up and forwarded to the Owner. Any additional equipment, installation and equipment floor space required to meet the distortion level as set forth in the Specification, shall be borne by the VFD manufacturer.

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, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Cleveland Clinic before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

END OF SECTION 23 05 13

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SECTION 23 0516 - EXPANSION FITTINGS AND LOOPS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Flexible, ball-joint, packed expansion joints and slip-joint packed expansion joints require periodic maintenance. Make sure the client is aware you are specifying.
 - 2. Flexible, ball-joint, packed expansion joints.
 - 3. Slip-joints are not suitable for refrigerant piping.
 - 4. Slip-joint packed expansion joints.
 - 5. Expansion compensators are only for pipe less than 4" in small spaces and only absorb axial movement.
 - 6. Expansion-compensator packless expansion joints.
 - 7. Rubber, Expansion-compensator packless expansion joints.
 - 8. Metal-bellows packless expansion joints.
 - 9. Only use grooved-joint if you are allowing "Victaulic" grooved mechanical couplings elsewhere in the project.
 - 10. Grooved-joint expansion joints.
 - 11. Pipe loops and swing connections.
 - 12. Alignment guides and anchors.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hydronic Piping"
 - 2. Division 23 Section "Hangers and Supports for HVAC"
 - 3. Division 23 Section "Vibration and Seismic Controls for HVAC"

1.03 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Paragraph below is defined in Section 01 3300 "Submittal Procedures" as a "Delegated-Design Submittal." Retain if Work of this Section is required to withstand specific design loads and design responsibilities have been delegated to Contractor or if structural data are required as

another way to verify compliance with performance requirements. Professional engineer qualifications are specified in Section 01 4000 "Quality Requirements."

- C. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
 - 5. **General Note: After Preconstruction coordination and per the delegated design aspect of the above specification, the contractor shall engage appropriate design professional to select piping expansion compensation method for all hot piping and submit as a shop drawing.**

1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of expansion joint, from manufacturer.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.

- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 PACKLESS EXPANSION JOINTS

- A. Metal, Expansion-Compensator Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Flex-Weld, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex, Inc.
 2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.
- B. Rubber, Expansion-Compensator Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.; Mercer Rubber Co.
 2. Material: Twin reinforced-rubber spheres with external restraining cables.
 3. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
- C. Flexible-Hose Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Metraflex, Inc.
 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with solder joint or flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
 9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- D. Metal-Bellows Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex, Inc.
 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 3. Type: Circular, corrugated bellows with external tie rods.
 4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 5. Single joint if pipe smaller than 2". Single with base if bigger than 2". Double if pipe will move both directions or is larger than 8".
 6. Configuration:
 - a. Axial movement only for NPS 2 and Smaller: Single Joint.
 - b. Axial movement only for NPS 2-1/2 thru NPS 6: Single Joint with base.
 - c. Axial movement only for NPS 8 and Larger: Double joint with base.
 - d. Axial and Transverse movement for all pipe sizes: Double joint with base.
 7. Expansion Joints for Copper Tubing: Multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or flanged.
 8. Expansion Joints for Steel Piping: Multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

E. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amber/Booth Company, Inc.; a div. of Vibration Isolation Products of Texas, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Flexicraft Industries.
 - d. Mason Industries, Inc.; Mercer Rubber Co.
 - e. Metraflex, Inc.
2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Spherical Type: Multiple spheres. Arch type is not acceptable.
5. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
6. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
7. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.
8. Materials for Fluids Containing Acids, Alkalies, or Chemicals: EPDM.
9. Materials for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.
10. Material for Water: EPDM.
11. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.03 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Alignment Guides should be placed on both sides of expansion joints, indicate locations on plans. Consult manufacturer rep for locations. Coordinate with structural for installation on steel and/or concrete.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advanced Thermal Systems, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Flexicraft Industries.
 - d. Flex-Weld, Inc.
 - e. Hyspan Precision Products, Inc.
 - f. Metraflex, Inc.
3. Indicate alignment-guide length and maximum spider travel on Drawings.
4. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stainless-steel studs are available. Use if in corrosive environment such as pools, water and wastewater treatment plans.

- b. Stud: Threaded, zinc-coated carbon steel.
- c. Expansion Plug: Zinc-coated steel.
- d. Washer and Nut: Zinc-coated steel.
- 5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stainless-steel studs are available. Use if in corrosive environment such as pools, water and wastewater treatment plans.
 - c. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - d. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- D. Install rubber packless expansion joints according to FSA-NMEJ-702.
- E. Install grooved-joint expansion joints to grooved-end steel piping

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. See the 2012 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Chapter 46 which states that cold springing is not recommended for most HVAC piping. If retaining first paragraph below, indicate dimensions of loops and swing connections and locations of guides and anchors on Drawings. Consult ASHRAE Handbook for sizing of pipe loops, L bends, Z bends, U bends, and anchor and guide location.
- B. Install pipe loops as shown on drawings and diagrams.
- C. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- D. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- E. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Indicate locations and number of guides on Drawings.
- C. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- D. Coordinate first paragraph below with structural Drawings if welding is included in structural work.
- E. Attach guides to pipe and secure guides to building structure.
- F. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- G. Anchor Attachments:
 - 1. Coordinate first subparagraph below with structural Drawings if welding is included in structural work.
 - 2. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- H. Coordinate first paragraph below with structural Drawings if welding is included in structural work.
- I. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- J. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 0516

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SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Grout.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.03 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
 - 3. Wade
 - 4. Josam
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing. Provide underdeck clamp with clamping ring and set screws for securement of fitting to slab.

2.04 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or outer dimension of pipe insulation for insulated pipe. Coordinate sleeve sizes with requirements of Section 23 0711 "Insulation".
 3. Increase sleeve size as required to provide additional annular space for project specific seismic conditions. Coordinate sleeve sizes with requirements of Section 23 0548 "Vibration and Seismic Controls".
 4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 9200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Coordinate sleeve sizes with requirements of Section 23 0711 "Insulation".
 2. Increase sleeve size as required to provide additional annular space for project specific seismic conditions. Coordinate sleeve sizes with requirements of Section 23 0548 "Vibration and Seismic Controls".
 3. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 4. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 5. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 6. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Concrete Slabs above Grade:
 - a. Piping, All sizes: Stack-sleeve fittings.
 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 0517

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SECTION 23 0521 - THERMOMETERS AND PRESSURE GAUGES

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SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
 - 1. Division 23 Section - Vibration and Seismic Requirements For HVAC
 - 2. Division 23 Section - Hydronic Piping
 - 3. Division 23 Section - Steam Piping
 - 4. Division 23 Section - Metal Ducts
 - 5. Division 23 Section - Air Duct Accessories.
 - 6. Division 23 Section - Centrifugal HVAC fans
 - 7. Division 23 Section - HVAC Power Ventilators

1.02 WORK INCLUDES

- A. Base Bid: Hangers and supports of plumbing piping and equipment are considered delegated design by Contractor. Design, Furnish and Install hanger and support systems for Plumbing Piping and Equipment as part of the Base Bid.

1.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe positioning systems.
 - 7. Steel Equipment supports.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural support and anchor design detailing is the responsibility of the Contractor unless otherwise specified or indicated on drawings. Support and anchor design calculations shall be provided to the Architect or Engineer upon request.
- B. Ligature resistant fixtures: Structural supports and anchors for design detailing is the responsibility of the Contractor for equipment, fixtures and devices specified under Div 23. In general, mounting shall resist forces of 200 lbs in the x, y and z direction. Support and anchor design calculations shall be provided to the Architect or Engineer upon request.

- C. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS

- A. Shop Drawings: Submit, for approval, complete calculations and details for field fabricated support installations (trapeze hangers, metal framing systems, and equipment supports); designed by a Registered Structural Engineer in the State in which the project is located. Submittal shall include Engineer's Seal affixed thereto.
- B. Show fabrication and installation details and include calculations for the following; include Product Data for components.

1.06 GENERAL REQUIREMENTS

- A. Hangers, structural supports, and attachments shall include all labor, supplemental steel, or other smaterial necessary for support of pipe furnished by Contractor. Factory fabricated items shall be complete with nuts, bolts, washers, etc. Where type and size are not indicated, proper selection shall be determined by Contractor. Refer to Noise & Vibration Isolation section of this specification for special support and hanger requirements.
- B. Refer to architectural and structural drawings for type of structure. Do NOT hang/support any single point loads greater than 500 lbs. from steel beams/purlins; and NOT greater than 250 lbs. from concrete slab or steel bar joists; unless specifically noted otherwise on the structural drawings. Weights shall not exceed framing member allowance. Where this Contractor violates allowances, any and all resultant damage and costs to correct, as determined by the Architect/Engineer, will be borne by this Contractor.
- C. Supports include equipment anchoring to floor slab, brackets to wall, hangers to equipment supported from structure above, etc. Refer to drawings for equipment and locations.
- D. Supplemental steel spanning structural framing elements may be steel angles or channels specifically sized for equipment/pipe weight. Supports shall be sized with a minimum safety factor of 5 to 1, or as required by code; most stringent requirement shall apply. Contractor may provide supplemental supports as manufactured by Unistrut, B-Line systems, or approved equal.
- E. Hangers and supports shall conform to recommendations of Standard Practice No. 58 and 69 of Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS).
- F. All exterior supports, hangers, attachments, etc. shall be galvanized or stainless steel; including all accessories, fasteners, etc.

1.07 REFERENCES

- A. American Concrete Institute, ACI:
 - 1. ACI 301: Specifications for Structural Concrete for Buildings.
 - 2. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 3. ACI 347: Recommended Practice for Concrete Formwork.
- B. American Society of Testing and Materials, ASTM:
 - 1. ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement.
 - 2. ASTM A185: Welded Steel Wire Fabric For Concrete Reinforcement.
 - 3. ASTM C33: Concrete Aggregates.
 - 4. ASTM C150: Portland Cement.
 - 5. ASTM C171: Sheet Materials for Curing Concrete.
 - 6. ASTM C260: Air-Entraining Admixtures for Concrete.
 - 7. ASTM C309: Liquid Membrane Forming Compounds for Curing Concrete.
 - 8. ASTM C404: Aggregates for Masonry Grout.
- C. American National Standards Institute, ANSI:
 - 1. ANSI/ASME B31.9: Building Services Piping.
- D. Concrete Reinforcing Steel Institute, CRSI:
 - 1. CRSI Manual of Standard Practice.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, MSS:
 - 1. MSS SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture.
 - 2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
- F. National Electrical Manufacturers Association, NEMA:
 - 1. NEMA ML 1: Metal Framing (Continuous Slot Metal Channel Systems).
- G. Sheet Metal & Air Conditioning Contractor's National Association, Inc., SMACNA:
 - 1. Duct Hangers: SMACNA Duct Manuals.

1.08 REGULATORY REQUIREMENTS

- A. International Building, Plumbing and Mechanical Codes, 2012 version.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of

application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.

- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 ACCEPTABLE MANUFACTURERS

- A. Hangers and Supports:
 - 1. Mason Industries: www.mason-industries.com.
 - 2. Nibco: www.nibco.com.
 - 3. PHD Mfg, Inc: www.phd-mfg.com.
 - 4. Bang-It
 - 5. Wood-Knocker
 - 6. Drop-In Anchors
- B. Saddles and Shields:
 - 1. Mason Industries: www.mason-industries.com
 - 2. Pipe Shields, Inc: www.pipeshieldsinc.com.
 - 3. PHD, Mfg., Inc.: www.phd-mfg.com.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Single Pipe Support: Provide factory fabricated horizontal piping hangers, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69.
 - 1. Type: Adjustable Steel Clevis; Type 1
 - 2. Use only one type by one manufacturer for each type of piping service.
 - 3. Select hangers and supports sized to exactly fit pipe size for bare piping; and to exactly fit around pipe insulation with saddle and shield for insulated piping.
 - 4. Provide rubber or neoprene lined pipe ring isolators and copper plated hangers and supports for copper piping systems.
 - 5. Size in accordance with MSS and manufacturer's recommendations, most stringent shall apply; minimum safety factor of 5.
 - 6. Based on Anvil Fig. 260 for insulated pipe of any type, non-insulated ferrous alloy pipe and non-insulated plastic pipe; Anvil Fig CT-65 copper plated carbon steel light duty adjustable clevis hanger for non-insulated copper piping NPS 1/2 thru 4.
- B. Trapeze Pipe Supports: Allowed for parallel runs of piping.
 - 1. Shop- or Field-fabricated: Provide MSS SP-69, Type 59 pipe support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
 - 2. Factory-fabricated: Provide channel strut system, B-line B22 or heavier as required for load and/or span lengths. Provide steel blocking of varying thickness welded to channel under each sloped pipe as required to obtain proper pitch. Strut clamps, straps, and rollers shall be used to maintain proper alignment:
 - a. Clamps and straps: B-Line series B2000 or B2400.

- b. Rollers: B-Line figures B218, B219, B379, B479 or B3126
- C. Pipe hangers and supports on insulated piping shall be installed outside the insulation and shall include insulation supports/inserts between the pipe and hanger/shield.
 - 1. Exception: Seismic restraint hangers and supports shall be installed in contact with the pipe. Insulation shall be carried over the hanger or support and sealed.

2.04 VERTICAL PIPING CLAMPS

- A. Provide factory fabricated vertical piping clamps, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69.
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Select vertical piping clamps to be sized to exactly fit pipe type and size of bare pipe.
 - 3. Provide rubber or neoprene line pipe ring and copper plated clamps for copper piping systems.
 - 4. Vertical risers shall be supported independently of horizontal branch hangers.
 - 5. Type:
 - a. At floor levels: MSS Type 8; two bolt riser clamp.
 - 1) Ferrous alloy and plastic pipe: Anvil Fig. 261 or Fig. 600/599; steel pipe/socket clamp.
 - 2) Copper pipe: Anvil Fig. CT-121; copper pipe riser clamp; carbon steel with copper finish.
 - b. Intermediate support between floor levels when floor to floor level exceeds maximum vertical distance allowable between supports: MSS Type 42; four bolt riser clamp; required in addition to riser clamps at floor levels. Provide with shear lugs welded to pipe, weldless eye nuts and hanger rods.

2.05 ATTACHMENTS

- A. Hanger Rod Attachments: Provide factory fabricated hanger rod attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Select size of hanger rod attachments to suit hanger rods; size attachments to suit equipment/pipe hanger/rod and applied load.
 - 3. Provide copper plated hanger rod attachments for copper piping systems.
 - 4. Type: MSS Type 13 Steel Turnbuckles
- B. Building Attachments: Provide factory fabricated hanger rod and brace angle attachments, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each type of piping service.
 - 2. Size attachments to suit equipment/pipe hanger/rod size and applied load.
 - 3. C-Clamps: MSS Type 23.
 - 4. Steel Brackets:
 - a. MSS Type 31 for light duty.
 - b. MSS Type 32 for medium duty.
 - c. MSS Type 33 for heavy duty.

2.06 SADDLES AND SHIELDS

- A. Provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping.
- B. Acceptable Manufacturers:
 - 1. Anvil
 - 2. Cooper/B-Line
 - 3. TOLCO Pipe Shields
 - 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 5. Value Engineered Products, Inc
- C. Size saddles and shields for exact fit to mate with pipe insulation
- D. Types:
 - 1. Protection Saddles: MSS Type 39, Anvil Fig 160-160A; fill interior voids with segments of insulation matching adjoining insulation.
 - 2. Protection Shields. MSS Type 40, Anvil Fig 167; length recommended by manufacturer to prevent crushing insulation, minimum length 12”.
- E. Insulation-Insert Material for Cold Piping: Utilize one of the following with vapor barrier:
 - 1. ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength, density ranging from 6.2 to 9.7 lb/cu. ft, and suitable for minus 450 to plus 800 deg F application.
 - 2. ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength, 6 lb/cu. ft. density, and suitable for minus 70 to plus 300 deg F application.
- F. Insulation-Insert Material for Hot Piping: Utilize one of the following, vapor barrier not required:
 - 1. ASTM C 533, Type I water-repellent treated calcium silicate with 100-psig minimum compressive strength, 15 lb/cu. ft. density, and suitable for 80 to 1200 deg F application.
 - 2. ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength, density ranging from 6.2 to 9.7 lb/cu. ft, and suitable for minus 450 to plus 800 deg F application.
 - 3. Permitted on low temperature heating water systems (200 deg F and lower) only, not permitted on steam and condensate: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength, 6 lb/cu. ft. density, and suitable for minus 70 to plus 300 deg F application.
- G. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- H. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- I. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.07 DUCT HANGERS AND SUPPORTS

- A. Strap Hangers: 18 gauge galvanized steel bands.

- B. Angle Iron: Galvanized angle iron with 3/8-inch rods.
- C. Wall Supports: Galvanized steel band iron or fabricated angle bracket.
- D. Vertical Support at Floor: Rolled 1-1/4 inch x 3/16 inch angle.
- E. Hangers: Support with stainless steel air-craft cable sized and rated for load, minimum size cable to be 7 x 9 - 3/32", with matching fastener rated for actual load installed with cable double looped on duct and at point of support. Acceptable products: Ductmate "Clutcher" or approved equal.

2.08 SPRING HANGERS AND SUPPORTS

- A. Provide factory fabricated spring hangers and supports, in compliance with ANSI/MSS SP-58 and ANSI/MSS SP-69
 - 1. Use only one type by one manufacturer for each piping service.
 - 2. Select spring hangers and supports to suit pipe size and loading.
 - 3. Types:
 - a. Spring Cushion Hangers: MSS Type 48
 - b. Constant Supports: Selected to suit piping system; including auxiliary stops for erection and hydrostatic test, and field load adjustment capability.
 - 1) Horizontal Type: MSS Type 54
 - 2) Vertical Type: MSS Type 55
 - 3) Trapeze Type: MSS Type 56

2.09 FLASHING MATERIALS

- A. Provide locations of roof penetrations to Roofing Contractor for Coordination.
 - 1. Roofing Contractor provides flashing material specified in Division 07.
 - 2. Provide flashings for each penetration of plumbing systems through floors, roofs or waterproofing membranes.

2.10 SLEEVES

- A. Pipes through floors where no plumbing fixtures are installed: 18 gauge galvanized steel.
- B. Pipes through Beams, Walls, Fireproofing, Footings, Potentially Wet floors: Schedule 40 steel pipe or 18 gauge galvanized steel.
- C. UL Labeled Sleeves: Prefabricated with insulation and fireproofing.
- D. Sleeves through Fire and/or Smoke Walls: Comply with NFPA 90A
- E. Size sleeves to allow for expansion movement and to provide for continuous insulation.
- F. Prefabricated Wall Penetration Seals: Modular mechanical type; interlocking synthetic rubber links filling annular space between pipe and wall opening.
 - 1. Description: Bolt and pressure plate fasteners and rubber seal provide water tight seal between pipe and wall.
 - 2. Seal provides electrical insulation between pipe and wall.

3. Based on: Thunderline Corporation Link Seal.

2.11 FIRE AND SMOKE PENETRATION SEALANT

- A. UL listed; flexible sealant or pre-fabricated metal device.

2.12 MISCELLANEOUS SUPPORT MATERIALS

- A. Metal Framing: NEMA Standard ML 1
- B. Structural Steel: ANSI/ASTM A 36, carbon-steel plates, shapes and bars; black and galvanized.
- C. Hanger Rods: Steel, threaded both ends, threaded one end, or continuously threaded.
- D. Cement Grout: Portland cement, ANSI/ASME C150, Type I or Type III, clean uniformly grades, natural sand, ANSI/ASTM C404, Size No. 2; mix ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water for placement and hydration, non-shrink, nonmetallic, suitable for interior and exterior applications.
 1. Properties: Non-staining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.
- E. Heavy Duty Steel Trapezes:
 1. Fabricate from steel shapes selected for applied loads.
 2. Weld steel in accordance with AWS standards.
 3. Pipe Guides: Factory fabricated cast semi-steel or heavy fabricated steel, including bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe.
 - a. Size guide and spiders to clear pipe, insulation and cylinder.
 - b. Guides Length: Recommended by manufacturer to allow required travel.

2.13 CONCRETE SUPPORTS

- A. Formwork: ACI 347.
- B. Reinforcement:
 1. Bars: ASTM A615, deformed, Grade 40, sizes 3 - 18.
 2. Steel Wire: ASTM A82, plain cold drawn.
 3. Welded Wire Fabric: ASTM A185; 6 inch x 6 inch, #10 x #10.
 4. Supports: Concrete Reinforcing Steel Institute.
 5. Concrete Materials:
 - a. Portland Cement: ASTM C150, Type 1, above or Type 2, below grade.
 - b. Aggregate: ASTM C33, meeting concrete strength requirements.
 - c. Water: Clean, free of substances harmful to concrete.
 - d. Air-Entraining Admixture: ASTM C260.
 - e. Calcium chloride not permitted.
 - f. Curing: Burlap cloth cover, 9 oz./sq.yd., AASHTO M182 Class 3 ASTM C171 moisture retaining cover; or ASTM C309, Type 1 membrane forming curing compound.
 6. Mixes:

- a. Purpose design mix for approval meeting indicated strength requirements, and submit test data on mix indicating compliance with strength requirements.
- b. Use air-entrained concrete at manufacturer's prescribed rate in all exposed concrete including below grade structures such as manholes and vaults.
- c. Mix Strength at 28 Days
 - 1) 3000 psi: Minimum 500 lbs, cement/cy; maximum 0.68 w/c/ratio.

2.14 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 3. Standard: MFMA-4.
 4. Channels: Continuous slotted steel channel with inturred lips.
 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 6. Hanger Rods: Continuous-thread rod, nuts, and washer.
 7. Coating: Galvanized if required elsewhere in this specification section; otherwise, manufacturer's standard factory paint coating.

2.15 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.16 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.17 EQUIPMENT SUPPORTS

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

2.18 ROOF EQUIPMENT SUPPORT RAILS

- A. Equipment support rails for roof-mounted equipment shall be constructed of 18 ga. galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, counterflashing with stainless steel screws or lag-bolts. Rails shall be internally reinforced per manufacturer's load calculations appropriate for equipment served.
- B. Support rails shall be extended canted type, for use with insulation board. Curb total height shall not exceed 12". Approved manufacturers shall be Pate or A/E approved equal.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments complete with inserts, bolts, rods, nuts, and washers in accordance with manufacturer's recommendations and as required to properly support piping from the building structure.
 - 1. Install hangers and supports to prevent sway, vibration, and sag.
 - 2. Support piping at drops to equipment to prevent stress at the equipment connections.
 - 3. Locate hanger within three feet of a direction change. Locate hangers within one foot of each horizontal elbow. Provide additional supports at each side of heavy valves and equipment. Valves NPS 3 and larger in horizontal piping shall be supported independently of the adjacent piping.
 - 4. Install hangers with minimum 1/2 inch clear space between finished covering and adjacent work.
 - 5. Use hangers with vertical adjustment range of 1-1/2 inch minimum suited for adjustment after piping is erected.
 - 6. Hanging of pipes from other trades (ie. Ductwork, conduits, ceiling suspension systems, medical equipment structural support systems, etc.) is not acceptable. Hanging and support of piping from other piping is not permitted, even of same trade.
 - 7. Adjust hangers and supports after insulation installation to provide uniform loading and to bring piping to proper levels and elevations.
 - 8. Use bracket type hangers fastened to walls to support piping running adjacent to walls and not supported from structure overhead.
 - 9. Perforated strap iron hangers and wire are not permitted for either temporary or permanent installation.
 - 10. Hangers and supports shall be securely fastened to structural members by beam clamps and clips, concrete inserts, anchors and all required accessories.
- B. Non-ferrous Piping: Copper plated and Plastic coated hangers and trapeze may contact non-ferrous piping. Ferrous hangers and supports, including trapeze members, must be isolated from non-ferrous pipe to prevent galvanic corrosion. Provide one of the following for installations mating ferrous hangers and supports with non-ferrous piping:
 - 1. Install split plastic shield, 6 inches long x 1/16 inch thick, 360 degree full circumference coverage with 225 deg F minimum rating between piping and hangers/supports.
 - 2. B-Line Vibra cushion clamps
 - 3. B-Line Iso Pipe rubber tape: Two (2) wraps extended 2 inches each side of hanger or clamp.

4. Black electrical tape or PVC tape: Three (3) wraps extended 2 inches each side of hanger or clamp.
 5. Painting of hangers, clamps and trapeze is not considered acceptable substitute to the above.
- C. Piping installed below slab on grade: Secure to avoid floating of piping during concrete pour; submit means and methods of securement for Engineer approval. For insulated piping, securements shall not be allowed to pierce the insulation or jacketing under any circumstances.
- D. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.02 EQUIPMENT BASES AND SUPPORTS

- A. Concrete:
1. Provide for major equipment reinforced concrete bases poured directly on structural floor slab 4 inches thick minimum, extended 4 inches minimum beyond machinery bedplates.
 2. Formwork: ACI 347.
 - a. Chamfer external corners of exposed concrete work.
 - b. Provide openings required by others as required.
 - c. Use manufacturer's templates or certified setting diagrams for placement of equipment anchor bolts and other mounting accessories.
 - d. Install accessories: Waterstops, expansion joints, and moisture barrier.
 - e. Reinforcement: CRSI, Manual of Standard Practice.
 - f. Concrete Placement: ACI 301, 304.
 - g. Concrete Curing : ACI 301.
 - h. Concrete Finishing:
 - 1) Horizontal Surfaces: Float and trowel to level, smooth, uniform, dense finish; leave struck off surface untroweled; or scratch struck off surfaces.
 - 2) Curbs: Strip form while concrete is green; steel trowel to hard dense finish with corners, intersections and terminations slightly rounded and coved.

- i. Concrete Grouting: Grout openings and recesses as indicated, around mechanical work using grouting mix, tamped, screened, troweled and cured.
 - 1) See individual equipment Sections for specification for fine grouting (nonshrink grout) of equipment base plates on foundation bases.
 - j. Field Quality Control: Contractor engages testing laboratory to take on site slump or compression tests to ensure compliance with specifications.
- B. Install lateral bracing with pipe hangers and supports to prevent swaying.
- C. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- D. Trapeze Hangers:
 - 1. Where piping of various sizes are supported together by trapeze hangers, space hangers to accommodate maximum span permitted for smallest pipe; or install intermediate supports for smaller diameter pipe(s).
 - 2. Strut clamps, straps, and rollers shall be used to maintain proper alignment. Provide a clamp/strut/roller in each straight run of pipe every 30 feet on center.
- E. Vertical Piping Risers: Support vertical piping risers independent of adjacent hangers on horizontal branches.
 - 1. Copper pipe: Support at the base of the riser and at each floor level; clamps not to exceed ten (10) feet on center. Provide additional supports for floor to floor heights exceeding 10 feet.
 - 2. Cast iron pipe: Support at the base of the riser and at each floor level; not to exceed fifteen (15) feet on center. Provide additional supports for floor to floor heights exceeding 15 feet.
- F. Pipe Movement: Install hangers and supports to allow controlled movement of piping systems
 - 1. Install hangers and supports to allow controlled movement of piping systems; to permit freedom of movement between piping anchors; and to facilitate action of expansion joints, expansion loops, expansion bends, and similar entities.
 - a. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement is not transmitted to connected equipment.
- G. Polypropylene pipe: Support at maximum 32 inch intervals horizontally and five (5) feet on center vertically with additional support at base of riser and at each floor level.
- H. Insulated Piping: Provide thermal-inserts and shields.
 - 1. Piping Operating above Ambient Air Temperature: Clamps supporting vertical piping may project through insulation. Hangers and supports for horizontal piping may not pass through insulation with the exception of saddles for roller support, seismic anchors, and seismic guides. Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 3. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 4. Install MSS SP-58, Type 39, protection saddles for above ambient services only at roller locations. Fill interior voids with insulation that matches adjoining insulation.
 - 5. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 6. Shield Dimensions for Pipe: Not less than the following:

- a. NPS 1/4 to NPS 2 (DN 8 to DN 90): 12 inches (305 mm) long and 18 gauge (0.048 inch (1.22 mm) thick).
 - b. NPS 2-1/2 to NPS 6: 18 inches long and 16 gauge (0.06 inch thick).
 - c. NPS 8 to NPS 14: 24 inches long and 14 gauge (0.075 inch thick).
 - d. NPS 16 to NPS 24: 24 inches long and 12 gauge (0.105 inch thick).
7. Pipes NPS 8 (DN 200) and Larger:
- a. Above ambient services: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - b. Below ambient services: Include reinforced cellular glass or polyisocyanurate insulation inserts of length at least as long as protective shield.
8. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 DUCT HANGERS AND SUPPORTS INSTALLATION

A. Low Velocity Ducts:

1. Hanger Minimum Sizes:
 - a. Up to 30 inches wide: 1-1/4 inch x 3/16 inch angle at 10 feet spacing.
 - 1) 31 inches to 48 inches wide: 1-1/2 inches x 3/16 inch angle at 10 feet spacing.
 - 2) Over 48 inches wide: 1-1/2 inches x 3/16 inch angle at 8 feet spacing.
 - 3) Horizontal Duct on Wall Supports Minimum Sizes:
 - a) Up to 18 inches wide: 1-1/2 inches x 16 gauge or 1 inch x 1 inch x 1/8 inch at 8 feet spacing.
 - b) 19 inches to 40 inches wide: 1-1/2 inches x 1-1/2 inches x 1/8 inch at 4 feet spacing.
 - 4) Vertical Duct on Wall Supports Minimum Sizes:
 - a) At 12 feet spacing.
 - b) Up to 24 inches wide: 1-1/4 inches x 3/16 inch angle.
 - c) 25 inches to 36 inches wide: 1-1/2 inch x 3/16 inch angle.
 - d) 37 inches to 48 inches wide: 1-1/2 inch x 1/4 inch angle.
 - 5) Vertical Duct Floor Supports Minimum Sizes:
 - a) Riveted or screwed to duct.
 - b) Up to 60 inches wide: 1-1/2 inches x 3/16 inch angle.
 - c) Over 60 inches wide: 2 inches x 2 inches x 3/16 inch angle.
 - 6) Covered Ducts: Install hangers below insulation with rod hangers.
 - 7) Lined Ducts: Install hangers below duct; sheet metal duct not punctured.
 - 8) Install hangers, supports to permit free, noiseless expansion and contraction.

B. Medium and High Velocity Ducts:

1. Rectangular Duct Hangers Minimum Sizes:
 - a. Up to 36 inches wide: 2 at 1 inch x 16 gauge at 10 feet spacing.
 - b. 37 inches to 60 inches wide: 2 at 1 inch x 16 gauge at 8 feet spacing and 2 inches x 2 inches x 1/4 inch trapeze.
 - c. 61 inches to 120 inches wide: 2 at 1-1/2 inches x 12 gauge at 8 feet spacing and 2 inches x 2 inches x 1/4 inch trapeze.
 - d. 121 inches to 240 inches wide: 3 at 3/8 inch diameter at 4 feet spacing and 2-1/2 inches x 2-1/2 inches x 3/16 inch trapeze.
2. Round Duct Hangers Minimum Sizes:

- a. At 10 feet spacings.
 - b. Up to 18 diameter: 1 inch x 16 gauge.
 - c. 19 inches to 36 inches diameter: 1 inch x 12 gauge.
 - d. 37 inches to 50 inches diameter: 1-1/2 inches x 12 gauge.
 - e. 51 inches to 84 inches diameter: 2 at 1-1/2 inches x 12 gauge from girth reinforcing angle.
 3. Vertical Duct Floor Supports Minimum Sizes:
 - a. Rivet to duct and tie angles together with rod, angles or cinch band.
 - b. Up to 48 inches wide: 1-1/2 inches x 1-1/2 inches x 1/8 inch.
 - c. Over 48 inches wide: 2 inches x 2 inches x 3/16 inch.
 4. Angle reinforcing may be used for support omitting trapeze.
- C. Round :
1. Use cable hangers in exposed areas.
 2. Size and spacing per manufactures recommendations.

3.04 PIPE HANGER AND SUPPORT SPACING SCHEDULE

- A. Based on piping sizes and material types, install at maximum span distances, with minimum hanger rod sizes as follows. Specification based on individual piping supports and does not apply to trapeze systems:
1. Horizontal Copper and Steel Piping:
 - a. NPS 1/2 to NPS 1-1/4: 6 feet maximum span, 3/8 inch diameter hanger rod.
 - b. NPS 1-1/2 to NPS 2: 10 feet maximum span, 3/8 inch diameter hanger rod.
 - c. NPS 2-1/2 to NPS 3: 10 feet maximum span, 1/2 inch diameter hanger.
 - d. NPS 4 to NPS 6: 10 feet maximum span, 5/8 inch diameter hanger rod.
 - e. NPS 8 to NPS 12: 10 feet maximum span, 7/8 inch diameter hanger.
 - f. NPS 14 and larger: 20 feet maximum span, 1 inch diameter hanger
 2. Horizontal Cast Iron Piping:
 - a. NPS 1-1/2 to NPS 2: 5 feet maximum span, 3/8 inch diameter hanger rod.
 - b. NPS 2-1/2 to NPS 3: 5 feet maximum span, 1/2 inch diameter hanger rod.
 - c. NPS 4: 5 feet maximum span, 5/8 inch diameter hanger rod.
 - d. NPS 6 to NPS 8: 5 feet maximum span, 3/4 inch diameter hanger rod.
 - e. NPS 10 to NPS 12: 5 feet maximum span, 7/8 inch diameter hanger rod.
 3. Hangers shall be placed adjacent either side of each piping joint and change in direction in addition to the above spacing criteria.

3.05 BUILDING ATTACHMENTS

- A. Space attachments within maximum piping spans indicated in MSS SP-69 and in spacing schedules this section. The most stringent, shortest distances shall apply.
- B. Install building attachments within concrete slabs or attach to structural steel.
- C. Concrete Structure Attachments:
1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3. Structural attachments shall be approved box type inserts for concrete floors and roof decks.
 - a. Continuous inserts may be used for parallel lines of piping and equipment. Furnish spot or strip inserts with Styrofoam or cardboard filler strip to protect the cavity during pour and subsequent construction activities.
 - b. Anchor insert attachment to structure shall be installed in accordance with the manufacturer's recommendation for the application and approved by the Structural Engineer.
 4. Self-drilling concrete anchors, Phillips Red Head Series, and powder-actuated fasteners, Hilti Fastening Systems or approved equal may be used only with prior approval by the Architect and Structural Engineer. If approved:
 - a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer.
 - b. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 5. Inserts and anchors shall not be installed in concrete pan construction between joists.
- D. Steel Joist Attachments: Connect to top chord of all steel joists for all hangers from steel attached to joists.
- E. Install additional building attachments when supporting additional concentrated loads, including valves, flanges, and strainers NPS 2-1/2 and larger and at changes in piping direction, guides, and expansion joints.
- F. Anchors:
1. Install anchors at locations preventing stresses from exceeding ANSI/ASME B31; and preventing transfer of loading and stresses to connected equipment.
 - a. Install anchors at ends of principal piping runs and at intermediate points in pipe runs between expansion loops and bends.
 - b. Preset anchors to accommodate both expansion and contraction of piping.
 2. Fabricate and install anchors by welding steel shapes, plates and bars to piping and to structure; in compliance with ANSI/ASME B31 and the American Welding Society (AWS).
 3. Anchors for Expansion Compensators: Install anchors in accordance with expansion unit manufacturer's recommendations.
 - a. Limit piping movement and forces to maximums recommended by manufacturer for each unit.

3.06 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Brace and fasten with flanges bolted to structure.
1. Supports: Configured of structural steel members or steel piping and fittings.
 2. Pipe Stands: Welded fabrication.
 - a. Provide flat plate supports for each leg, bolted to 6 inch high x 12 inch x 12 inch concrete base poured on floor. Alternatively, bolt support to floor and encase

flange and anchor bolts in 6 inch high x 12 inch x 12 inch concrete base to be water proofed and sealed after curing.

- b. Attach top of each leg to ceiling or roof structure as indicated or approved.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.
- D. Provide rigid anchoring for piping immediately after vibration connections to equipment and immediately after vibration isolator at transition from spring isolated piping rack to rigidly hung piping rack.

3.07 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.08 FLASHING

- A. Flash and counterflash where mechanical equipment passes through the roof, weather or waterproofed walls and floors.
 - 1. Coordinate with and accommodate specified roofing systems.
 - 2. Ensure compatibility with number and type of roofing plies.
 - 3. Vertical Surfaces: Lap flashings minimum 3 inches.
 - 4. Embed metal flashing flanges in roofing or composition flashing or stripping, by extending flanges minimum 6 inches for embedment.
 - 5. Pipes Through Outside Walls: Turn flange back into wall and seal.
 - 6. Curbs:
 - a. Provide curbs for mechanical roof installations 12 inches minimum high.
 - b. Flash and counterflash with steel, soldered and waterproofed.

3.09 SLEEVES

- A. Setting: Set sleeves in advance of concrete work; provide reinforcing around sleeves.
- B. Wet Areas: Extend sleeves through potentially wet floors 2 inch above finished floor level.
 - 1. Caulk sleeves full depth and provide floor plate.

2. Insulation: Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and construction with noncombustible mineral wool insulation.
 - a. Provide tight fitting metal caps on both sides and caulk.
3. Install chrome plated escutcheons where piping passes through finished surfaces.
4. When duct sleeves pass through fire and smoke barriers, pack void space between duct and sleeve with fireproof mineral wool.
 - a. Provide sheet metal duct flanges at wall to cover openings.
5. Prefabricated Wall Penetration Seals: Install and tighten seals in accordance with manufacturer's recommendations.
 - a. Ensure watertight pipe penetration.

3.10 FIRE AND SMOKE PENETRATION SEALANT

- A. Where supports pass through fire or smoke rated walls, partitions, floors, and ceilings, seal openings with UL rated materials.

3.11 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.12 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 9123 "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Exposed Steel Surfaces: Prime coat all exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.13 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Individual Hangers and Supports: Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
 - 2. Trapeze support system (MSS Type 59) with piping clamps or U-bolts (MSS Type 24) for support of pipes NPS 1/2 to NPS 30.
 - 3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 with vertical adjustment capability, steel-pipe base stanchion support and cast-iron floor flange.
 - 4. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 from two rods where longitudinal movement caused by expansion or contraction occurs.
 - 5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod where horizontal movement caused by piping expansion or contraction occurs.
 - 6. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 where horizontal movement caused by piping expansion and contraction occurs and with vertical and lateral adjustment capability during installation.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps or if additional intermediate supports between floors utilizing eyelets and additional hanger rod are required.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 4. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 23 0529

SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Supplemental Steel bases.
 - 2. Vibration isolators.
 - 3. Seismic restraints.
- B. Related Sections:
 - 1. Division 23 Section "Hangers and Supports for HVAC"
 - 2. Division 23 Section "Metal Ducts"
 - 3. Division 23 Section "Hydronic Piping"

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Seismic Design Category: D; Refer to Structural Drawings for additional seismic design parameters.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV
 - 3. Component Importance Factor: 1.5 for all systems Life Safety systems and Fire Sprinkler systems. Building is considered Occupancy Category IV, thus systems deemed essential to the continued operation of the facility are assigned a component Importance Factor of 1.0. All systems, piping and equipment other than Fire Sprinkler and Life Safety systems shall be assigned 1.0 Component Importance factor. Refer to Restraint Schedule in Part 3 of this Section for items requiring restraint according to the above Criteria and ASCE 07.

1.04 SUBMITTALS

- A. Product Data: Provide schedule of vibration isolator type with location and load on each. Include spring constant, spring horizontal to vertical stiffness, maximum load capacity, color codes, neoprene durometer.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
- C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

- D. Design: All spring isolators shall be completely stable in operation and shall be designed for not less than 30 percent reserve deflection beyond actual operating conditions. Open spring isolators shall be designed such that the horizontal to vertical spring stiffness ratio shall be 0.8 or greater for stability. All elastomeric isolators shall be of neoprene high quality synthetic rubber with anti-ozone and anti-oxidant additives. Steel components shall be cleaned and painted. All nuts, bolts, and washers shall be zinc electroplated. Structural steel bases thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 20 lb/sq. ft. applied to any exposed surface of the isolated equipment.
- E. Delegated Design Submittal:
1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 3. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors,
 4. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 5. Coordination Drawings; Show coordination of seismic bracing for Division 21,22,23 and 26 equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- F. Welding certificates.
- G. Qualification Data: Professional engineer and testing agency

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An Independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910, 7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing

are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
1. Vibration Mountings and Controls - Amber Booth
 2. Kinetics Noise Control, Inc
 3. Mason Industries

2.02 SUPPLEMENTAL STEEL BASES

- A. Single Steel I-beams
1. Dimensions: Beams shall have a minimum section depth of 8% of the longest span between vibration isolator supports; down to a minimum of 6"; of size and shape required for the equipment to be supported.
 2. Loading: Structural steel base shall provide a rigid, distortion free, mounting base for supported equipment, which allows no excessive differential motion between the equipment and structural steel base.
 3. Anchoring: Provide prelocated and drilled anchor bolt holes into all structural steel bases to bolt down equipment.
- B. Steel Frames for Fans
1. Steel base depth: Frames shall be steel beams or channels with a minimum depth of 8% of the longest span between isolators; minimum of 6" depth, maximum of 12" depth.
 2. Dimensions: Sized to prevent distortion and misalignment of the drive mechanism, and to limit beam deflection on the drive side of .05 inches at starting torque.
 3. Frame: Structure steel members and motor slide rail with holes predrilled to align with the fan and motor.
 4. Height Saving Brackets: Shall be welded to the structural steel base or shall be formed as an integral part of the frame. Provide the lowest possible mounting heights with a minimum 1/2" base clearance.

2.03 VIBRATION ISOLATORS

- A. Open Spring Isolators:
1. Springs: Minimum horizontal stiffness equal to 80% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Spring Mounts: Provide with leveling devices, minimum 0.10 inch thick neoprene sound pads, and zinc chromate plated hardware.
 3. For equipment demonstrating lateral dynamic forces greater than 50% of the equipment weight, provide base plate and bolt holes for attachment to the support structure.
- B. Housed Spring Isolators with limit stops:

1. Springs: Minimum horizontal stiffness equal to 80% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, minimum 0.10 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Mounting: Complete with bolt holes in the base plates to provide for attachment to the equipment and support structure.
4. Maintain a minimum 1/4" clearance around restraining bolts or housing limit stops to prevent interference with spring action.
5. Housing: Steel enclosed constructed to carry equipment weight and serve as blocking during equipment installation.
6. Seismic Capacity: When used for seismic restraint application, provide all Code required restraint calculations. Maintain 1/8" clearance at restraining bolts.

C. Spring Hangers:

1. Springs: Minimum horizontal stiffness equal to 80 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Neoprene element: Molded with a rod isolation bushing and double deflection neoprene block.
3. Spring diameters and hanger box lower holes; large enough to permit the hanger rod to swing through 30 degree arc before contacting the isolator housing and short circuiting the spring.
4. Housing: Rectangular steel box constructed to carry the equipment weight without deformation.

D. Neoprene Pad Isolators:

1. Neoprene waffle pads.
 - a. Hardness: 30 durometer, or durometer required for specified load deflection.
 - b. Thickness: Minimum 3/4 inch (20 mm).
 - c. Maximum Loading: 50 psi.
 - d. Rib Height: Maximum 0.7 times width.
2. Configuration: Single layer, or waffle pads bonded each side of 1/4 inch (6 mm) thick steel plate.
3. For equipment demonstrating lateral dynamic forces greater than 50% of the equipment weight, provide base plate and bolt holes for attachment to the support structure.

2.04 SEISMIC RESTRAINTS

A. Seismic Snubbers:

1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding all combined static and dynamic forces, both direct and response amplified during a seismic event.

B. Seismic Cable Brace

1. Seismic Restraint: In the installed condition the restraint system shall be structurally capable of withstanding all combined static and dynamic forces, both direct and response amplified, during a seismic event. Restraint shall take place in all suspended modes and limit travel by a 1/8 - 1/4 inch slack in the aircraft cable. Equipment shall be bolted to building structure to resist all applicable seismic forces.
 2. Installation: Cable braces shall be utilized for suspended piping and mechanical equipment in conjunction with spring hangers or suspended ductwork or piping. Cables shall be installed at 45 degree or alternate angles to suspend equipment. Motion shall be restricted in two horizontal directions and in the downward vertical direction.
 3. Submittals: Shall provide all seismic load calculations and drawings demonstrating compliance with the governing criteria. If limited access prevents installation at 45 degrees, seismic calculations shall be submitted to demonstrate compliance with alternate angles.
- C. Seismic Rod Clamp
1. Seismic Restraint: Hanger rod steel angle and locking bolts used in conjunction with spring hangers or suspended ductwork or piping. In the installed condition the reinforcement system shall be structurally capable of withstanding all combined static and dynamic buckling forces, both direct and response amplified, during a seismic event.
 2. Installation: Shall be in accordance with manufacturers' seismic load calculations, and rod clamp spacing based on rod diameter with a minimum of 3 clamps per rod.
 3. Submittals: Shall include all seismic load calculations and drawings demonstrating compliance with the governing criteria.
- D. Neoprene Washer-Bushing
1. Applications: For seismic relief at spring or neoprene isolator baseplate bolt holes.
 2. Submit: Durometer according to ASTM D676; tensile strength and percent elongation at break according to ASTM D412; over aging hardness, tensile strength and elongation at break according to ASTM D573; and compression set according to ASTM D395.
- E. General Requirements for Restraint Components
1. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 2. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
 3. Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 4. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 5. Resilient Isolation Washers and Bushings: Oil-and water-resistant neoprene.
 6. Maximum 1/4-inch air gap, minimum 1/4-inch thick resilient cushion.
 7. Channel Support System: MFMA-3, shop- or field fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
 8. Restraint Cables: A3TM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and belts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

9. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
10. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
11. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
12. Resilient isolation Washers and Bushings: One-piece, molded, Oil-and water-resistant neoprene, with a flat washer face.
13. Mechanical Anchor Bolts: Drilled in and stud-wedged or female-wedged type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488, Minimum length of eight times diameter.
14. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.05 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
- B. Design requirements: Lowest possible mounting height with no less than 1-inch clearance above the floor, include equipment anchor bolts and auxiliary motor slide bases or rails.
- C. Include supports for suction and discharge elbows for pumps.
- D. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- E. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- F. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
- G. Design requirements: Lowest possible mounting height with no less than 1-inch clearance above the floor, include equipment anchor bolts and auxiliary motor slide bases or rails.
- H. Include supports for suction and discharge elbows for pumps.
- I. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
- J. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- K. Fabrication: Fabricate steel templates to hold equipment anchor-bolt cleaves and anchors in place during placement of concrete. Obtain anchor-belt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installation and Quality Control: Except as otherwise indicated, the contractor shall comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading. Remove space blocks and similar devices intended for temporary protection against overloading during installation. Anchor and attach units to structural supports and equipment as required. Adjust leveling devices as required where leveling uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Where equipment base frames are specified, install base frames on isolator units so that a minimum of 1/2" clearance below the base will result when the supported equipment has been installed and loaded for operation. (2" clearance for inertia bases). The contractor shall adjust all vibration isolators after the system has achieved full operating weight so that: no vibration isolation element is short circuited; no undue stress is applied to the equipment, connected piping or structure; and no noise is transmitted to any support structure, connected surface or adjacent environment. After equipment installation and operation, it shall be the contractors' responsibility to demonstrate that the isolation system meets all of the criteria specified in this Section and on the Drawings, and has been properly installed.
2. On housed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
4. Where fan/duct flexible duct connectors are used, provide pairs of horizontal thrust restraint springs on centrifugal fans with more than 6.0 inches WC total static pressure, and on hanger supported, horizontally mounted axial fans with more than 3.0" W.C. total static pressure.
5. Provide isolated or integral seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 1/8 inch maximum clearance.
6. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for the first three points of support.

3.02 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. General

1. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on Plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Seismically restrain all of the following piping:
 - a. Piping located in boiler rooms, and mechanical equipment rooms that is NPS 1-1/4 and larger
 - b. All other piping NPS 2-1/2 and Larger.
 - c. Piping racks containing multiple piping types and sizes supported by trapeze systems.
2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction,
5. For all gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.

D. Ductwork Restraints:

1. Seismically restrain all duct work and equipment as listed below:
 - a. Restrain rectangular ducts with cross section area of 6 square feet or larger.
 - b. Restrain round ducts with diameters of 28 inches or larger.
 - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
 - d. Restrain components installed in-line with the duct system such as fans, heat exchangers and humidifiers that have an operating weight greater than 75 lbs; support and brace components independently of the duct system.
 - e. All hazardous exhaust duct systems regardless of size. Exhaust duct systems serving Chemotherapy compounding room and hoods shall be considered hazardous exhaust.
2. Transverse restraints shall occur at 30' intervals or at both ends of the duct run if it's length is less than the specified interval. Transverse restraints shall be installed at each duct run and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' of the intersection of the ducts and if the restraints are sized for the larger duct. Joints in ducts shall conform to SMACNA duct construction standards.

4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork shall be attached to both upper angle and lower trapeze.
 5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
 6. Walls, including gypsum board non-bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for components.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors. Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- K. Seismic Restraint Exclusions
1. Piping
 - a. All piping NPS 2 and Smaller except those listed below.
 - b. All piping in boiler and mechanical equipment rooms NPS 1 and Smaller.
 - c. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than 12-inches in length from the structure to the structural connection of the clevis or trapeze. Hangers shall be equipped with swivels, eye-nuts, or other devices to prevent bending in the rod.

2. Ductwork
 - a. Rectangular, square or oval ducts (other than hazardous exhaust) less than 6 square feet in cross sectional area.
 - b. Round duct (other than hazardous exhaust) less than 28 inches in diameter.
 - c. Duct supported by hanger rods where point of attachment is less than 12 inches in length from the structure to the structural connection of the duct work and the hanger rod is equipped with swivels to prevent inelastic bending in the rod.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. All major rotating and reciprocating mechanical equipment (5 HP and larger) shall be mounted with spring isolators with a minimum of 2 inch static deflection.
- B. All piping connected to rotating and reciprocating shall be mounted with spring isolated hangers within the mechanical room or 50 feet whichever is greater.
- C. All piping and ductwork shall be mounted with spring isolated hangers at the bottom of all shafts greater than 3 floors.
- D. Seismic restraint of equipment must not inhibit vibration isolation.
- E. Housed spring mounts that accommodate both vibration and seismic requirements shall be submitted for review prior in acceptance.
- F. The following HVAC systems require restraint based on specified Seismic Design Category and Building Occupancy Category.
 1. All critical exhaust systems ductwork and equipment conveying exhaust air stream from the compounding suite.
 2. Piping and Ductwork systems weighing more than 5 lb / ft
 3. Equipment weighing more than 20 lb.
 4. Equipment weighing 400 lb or less and having a center of mass located 4 ft or lower above floor level.
- G. The following HVAC Systems are considered essential for the continued operation of the facility and shall be seismically restrained:
 1. Heating Water System, equipment and piping.
 2. HVAC ducts and equipment serving patient care spaces including supply, return, and exhaust.
 3. HVAC systems serving IDF room cooling.
 4. Temperature control systems serving the above restrained systems.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 piping Sections for piping flexible connections.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency; Engage a qualified testing agency to perform tests and inspections.
- B. Tests and inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
- C. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
- D. Test to 90 percent of rated proof load of device.
- E. Measure isolator restraint clearance.
- F. Measure isolator deflection.
- G. Verify snubber minimum clearances.

END OF SECTION {CH#10002543}

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SECTION 23 0553 - IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes
 - 1. Equipment Nameplates.
 - 2. Pipe Labels.
 - 3. Duct Labels.
 - 4. Valve Tags.
 - 5. Stencils.

1.03 REFERENCE STANDARDS

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturers catalog literature for each product required.
- B. Valve Tag Layout: Provide sample drawing of proposed valve tag with letter sizing and arrangement.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Valve numbering scheme.
- E. Closeout submittals: Valve tag chart included in O&M's and valve tag chart in frame for mounting in location determined by Owner.

1.05 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceiling and similar concealment.
- D. Coordinate identification methods with facility's standards for consistency with methods in use elsewhere in the existing facility.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following.
 - 1. Brady Corporation
 - 2. Kolbi Pipe Marker Co.
 - 3. Marking Services, Inc.
 - 4. MIFAB, Inc.
 - 5. Seton Identification Products.

2.02 IDENTIFICATION APPLICATIONS

- A. Provide identifying devices for the following systems including piping, ductwork, and associated equipment:
 - 1. Heating Water.
 - 2. Air handling systems, including supply, return, outside air and exhaust.
 - 3. General and specialty exhaust systems.

2.03 EQUIPMENT NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch.
 - 3. Background Color: Black.
 - 4. Thickness: 1/8 inch.
- B. Label Content: Include equipment's Drawing designation where drawing designation is unique or unique. Where equipment number is not unique in the drawing set (ie multiple water heaters tagged as WH-1), submit proposed unique designation system for use in identifying each individual piece of equipment.
- C. Equipment labeling requirements do not apply to plumbing fixtures.

2.04 TAGS

- A. Metal Tags: 0.032-inch minimum thick brass with predrilled or stamped hole for attachment hardware. Letters to be stamped; tag size minimum 1-1/2 inch diameter with smooth edges.
- B. Tag Lettering size: Minimum 1/4 inch height for name of units where viewing distance is less than 24 inches, 1/2 inch minimum height for distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.
- C. Valve Tag Fastener: Brass wire link or beaded chain with S-hook.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

- E. Valve Tag Content: On each valve tag include system designation (ie CW = Cold Water), numerical valve designation, (ie -001), and valve vintage (ie 2014) to designate year of installation.

2.05 DUCT LABELS

- A. Description: Multilayer, multicolor, plastic labels for mechanical engraving 1/8-inch thick, and having predrilled holes for attachment hardware.
 - 1. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 2. Minimum Letter Size: 1-1/2 inches high. Where duct viewing distance is greater than 10 feet, minimum letter size shall be 2-1/2 inches high.
- B. Fasteners: Stainless-steel rivets. For insulated duct, rivet shall be of length required to not compress insulation. Provide steel grommet of length equal to insulation thickness to not compress insulation with attachment of duct label.
- C. Duct Label Contents: Include identification of duct service type (listed below), associated air handler unit or HVAC power ventilator, size of duct in inches, and arrow indicating flow direction. Flow direction arrows may integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
- D. Duct Service Types: Provide full lettering of types as follows; Abbreviations are not acceptable.
 - 1. Supply Air: Includes medium pressure and low pressure.
 - 2. Return Air
 - 3. General Exhaust
 - 4. Isolation Exhaust

2.06 PIPE LABELS

- A. Comply with ANSI/ASME A13.1.
- B. Label all piping systems with factory-fabricated, preprinted, color-coded, with lettering indicating service type and pipe size, and showing flow direction.
- C. Construction type and Lettering size shall be based on pipe or pipe covering approximate sizes.
 - 1. Pipes or Pipe covering 3/4" and smaller: Letter size 1/2 inch, label similar to 1 inch through 2-1/2 inch size below shall be used.
 - 2. Pipe or Pipe covering size 1 inch to 2-1/2 inch diameter: Letter size 3/4 inch.
 - 3. Pipe or Pipe covering size 2 inch to 6 inch diameter: Letter size 1-1/4 inch.
 - 4. Pipe or Pipe covering size 6 inch to 10 inch diameter: Letter size 2-1/2 inch.
 - 5. Construction type: Pipe Labels shall be self-adhesive printed flexible vinyl plastic with contact-type, permanent acrylic adhesive backing coating minimum 1.0 mil thick. Provide full circumference banding tape of similar construction to label with full circumference arrow markings to indicate flow direction
- D. Pipe Label Contents:
 - 1. Include identification of the the piping service (fluid conveyed) utilizing common English terminology (ie. Heating Water Supply) in lieu of abbreviations used on Drawings.

2. Indicate Pipe Size at every label location.
3. Indicate fluid flow direction with Arrows at every label location.
4. Pressure of contents where various pressure systems of same fluid occur on project, i.e. High Pressure Steam (100 psi).
5. Temperature of contents where various temperatures of same fluid occur on project, i.e. High Temperature Heating Water (350F) versus Heating Water (180F)
6. Insulated piping shall be labeled as "Non-Asbestos".

E. Schedule for banding and labeling of pipe and conduit will conform to ANSI/ANSI A13.1.

2.07 VALVE AND DEVICE IDENTIFICATION CEILING TAGS

- A. Description: 3/4" x variable length vinyl tape for use with thermal transfer printer. 3.0-mil film, acrylic-adhesive with polished face. UV, moisture, and abrasion resistant with 5 year warranty.
- B. Provide clear plastic printed ceiling identification tags for HVAC valves, controls, and other above ceiling equipment components. In addition, label all above ceiling components at each location in accordance with the Facility's established standards.
- C. Color: Ceiling tags to be clear background with black letters.
- D. Contents: Label text shall be in accordance with the Facility's established standards.
- E. Install ceiling identification tags per the Facility's established standards.
- F. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.08 STENCILS

- A. Duct Systems Stenciling: For uninsulated ducts and double wall ducts, stenciling shall be permitted in lieu of duct labeling criteria specified above. Stenciling of Insulated duct systems not permitted.
- B. Pipe Systems Stenciling: Not permitted.
- C. Size and color of stenciling and background paint for stenciling shall be in accordance with ASME A13.1. Provide schedule of proposed colors for duct systems that apply to the project, including proposed stenciling terminology and letter sizes. Include airflow direction either side of stenciled label.

PART 3 - EXECUTION

3.01 IDENTIFICATION APPLICATIONS

- A. Provide the following:
 1. Air Handling Units: Nameplates.
 2. Air Terminal Units: Nameplates.
 3. Automatic Controls: Tags. Key to control schematic.
 4. Control Panels: Nameplates.

5. Dampers: Color coded tag, where located above lay-in ceiling; printed or stenciled position indicators.
6. Ductwork: Labels printed with service and direction of flow.
7. Equipment: Nameplates.
8. Heat Transfer Equipment: Nameplates.
9. Instrumentation: Tags.
10. Major Control Components: Nameplates.
11. Piping: Labels printed with service and direction of flow.
12. Pumps: Nameplates.
13. Relays: Tags.
14. Small-sized Equipment: Tags.
15. Tanks: Nameplates.
16. Thermostats: Nameplates.
17. Valves: Tags.

3.02 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair the bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- B. Degrease and clean surfaces to receive adhesive for identification materials.

3.03 EQUIPMENT NAMEPLATE INSTALLATION

- A. Locate equipment nameplates where accessible, readily visible, and not subject to physical abrasion by routine equipment maintenance.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- C. Identify pumps, compressors, tanks, water heaters, water treatment devices, medical gas manifolds, and all other pieces of equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

3.04 PIPE LABEL INSTALLATION

- A. Install plastic pipe markers in accordance with manufacturer's instructions. Lettering shall be visible from the floor.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; equipment rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch where flow pattern is not obvious.
 3. Near penetrations through walls, floors, ceilings and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Mark major equipment items and other points of originaation and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 15 feet in areas of congested piping .

C. Pipe Label Color Schedule:

1. Chilled Water Piping: Green background with White lettering.
2. Heating Water Piping: Yellow background with Black lettering.

3.05 DUCT LABEL INSTALLATION

- A. Install plastic laminated duct labels with rivets on ducts in the following color codes.
 1. HVAC Supply, Return, Outside air and Relief: Green background with White lettering.
 2. General Exhaust: Yellow background with Black lettering.
 3. Hazardous Exhaust systems (including Isolation and Fume Hoods): Orange background with Black lettering.
- B. Locate labels nrear points where ducts enter into concealed spaces and as they leaves fan rooms. Label HVAC and general exhaust ducts every 30 feet in spaces where ducts are exposed or concealed by removable ceiling systems. Label Hazardous Exhaust systems every 20 feet from origination to exit point of the building. Provide warning labels at hazardous exhaust points where building occupants or service personnel could inadvertently expose themselves to the hazardous substances being exhausted.

3.06 VALVE TAG INSTALLATION

- A. Install tags with corrosion resistant chain on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Use tags in addition to labels on piping 3/4 inch diameter and smaller.
 1. Identify service, flow direction, and pressure.
 2. Install in clear view and align with axis of piping.
 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Identification of Non-potable CW piping not to exceed 4 feet.
- C. Identify valves in main and branch piping with tags.
- D. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to valve.

END OF SECTION 23 0553

SECTION 23 0591 - HVAC SYSTEM STARTUP

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes:
 - 1. Startup of all installed equipment and systems. Provide all information and assistance for cooperation with the testing, adjusting and balancing services.
 - 2. All work specified herein shall be complete prior to the start of the balancing procedures.
- B. Related Sections:
 - 1. Division 23 Section - Hydronic Piping
 - 2. Division 23 Section - Testing-Adjust-Balance

1.03 SUBMITTALS

- A. Product Data: Including performance data for temporary circulation pump to be used for flush and cleansing of closed loop hydronic systems.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 START-UP PROCEDURES

- A. Bearings:
 - 1. Inspect for cleanliness. Clean and remove foreign materials.
 - 2. Verify alignment.
 - 3. Replace defective bearings and those which run rough and noisy.
 - 4. Lubricate as recommended by manufacturers.
- B. Drives:
 - 1. Adjust tension in V-belt drives; adjust veripitch sheaves and drives for proper equipment speed.
 - 2. Adjust drives for alignment of sheaves and V-belts.
 - 3. Clean, remove foreign materials before starting operation.
 - 4. Replace fan sheaves as required and identified by the TAB Contractor to achieve design air flows.
- C. Motors:

1. Inspect each motor for amperage comparison to nameplate value.
 2. Correct conditions which produce excessive current flow which exist due to equipment malfunction.
- D. Pumps:
1. Inspect:
 - a. Mechanical seals for cleanliness and adjustment before operating pump.
 - b. Shaft sleeves for scoring.
 - c. Mechanical faces, chambers and seal rings. Replace if defective.
 2. Verify that piping system is free of dirt and scale before circulating liquid through pump.
- E. Control Valves:
1. Inspect both hand and automatic control valves; clean bonnets and stems.
 2. tighten packing glands to assure no leakage, but permit valve stems to operate with galling.
 3. Replace:
 - a. Packing in valves to retain maximum adjustment after system is judged complete.
 - b. Packing on all valves which continue to leak.
 4. Remove and replace bonnets which leak.
 5. After cleaning, coat packing gland threads and valve stems with a surface lubricant.
- F. Verify that control valve seats are free from foreign material and are properly positioned for intended service.
- G. Tighten flanges after system has been placed in operation.
1. Replace flange gaskets which show sign of leaking after tightening.
- H. Inspect screwed joints for leakage. Promptly remake each joint which appears to be faulty; do not wait for rust to form.
- I. After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems to assure being free from foreign materials.
- J. Open steam traps and air vents, remove operating elements.
1. Clean thoroughly, replace internal parts and put back in operation.
- K. Remove rust, scale and foreign materials from equipment and renew surfaces.
- L. Install clean air filters. Set and calibrate draft gauges of air filters and other equipment.
- M. Inspect fan wheels for clearance and balance.
1. Provide factory-authorized personnel for adjustment when needed.
- N. Inspect each electrical control circuit to assure that operation complies with specifications and requirements to provide desired performance.
- O. Inspect each pressure gauge and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.
- P. Repair damaged insulation.

- Q. Vent gasses trapped in systems. Verify that liquids are drained from all parts of gas or air systems.
- R. Inspect piping for leaks at every joint, and at every screwed, flanged or welded connection, using a proper leak detecting method.

3.02 SYSTEM CLEANING

- A. Prior to start-up, new or extensively extended chilled water and heating hot water systems shall be cleaned. Provide system valves, hose connections and access points to flush, fill, and clean new portions of system without connecting to existing systems that remains in service throughout this project. Provide temporary circulation pump of appropriately sized to circulate fluid and cleansing agent through system without using existing pumping systems already in service.
- B. After cleaning, the system's water shall not contain a suspended solids count above 25 parts per million of solids 1.2 microns or larger, shall be essentially free of cutting thread oil (below 5 parts per million), and the system's pH shall be 8.0 or above. There are three different procedures for the chemical flushing of systems: 1) Trisodium Phosphate - Caustic, 2) Acrysol A-1 and Dequest 2010, and 3) Drewsperser 4945/Drewsperser 4395.
 - 1. Trisodium Phosphate - Caustic: After the system is filled with water, 3 pounds of trisodium phosphate and 3 pounds of sodium hydroxide shall be added for every 1000 gallons of volume. This solution shall be circulated throughout the system for 12 hours, drained, and rinsed twice. CAUTION: This procedure is not to be used if metals such as, aluminum or galvanized steel are present in the system. The alternate methods 2 and 3 may be used in these systems.
 - 2. Acrysol A-1 and Dequest 2010: After the system is filled with water, add 1 gallon of cleaning concentrate for every 100 gallons of system volume. The cleaning concentrate is prepared as follows:
 - a. In 100 gallons of water, add the following chemicals and mix until thoroughly dissolved. Add chemicals in the following order and quantity. Use a polyethylene drum.
 - 1) Acrysol Grade A-1 (Rohm and Haas): 41.5 pounds
 - 2) Dequest 2010 (Monsanto): 41.5 pounds
 - 3) Potassium Hydroxide: 12.5 pounds
 - b. The cleaning solution shall be circulated throughout the system for 24 hours, preferably under light heat (100° - 120°F) if possible, drained, and rinsed twice.
 - 3. Drewsperser 4945/Drewsperser 4395: These are preblended proprietary cleaning solutions. Drewsperser 4945 is a combination of polymers, chelate, and a gluconic acid derivative designed to remove iron and copper oxides from the system. Drewsperser 4395 is a low-foaming, non-ionic surfactant which effectively disperses mud, silt, clay, oil, and other suspended matter from the system, allowing these to be carried out of the system by flushing. After the system is filled with water, add 1 gallon of Drewsperser 4945 and 1 gallon of Drewsperser 4395 for every 1000 gallons of system volume. This solution shall be circulated throughout system for 12 hours at 120°F if possible, drained, and rinsed twice.
- C. All automatic valves shall be open when cleaning system to allow circulation through coils. After rinsing, a sample shall be submitted for analysis to determine that the system has been adequately cleaned prior to installing glycol or adding corrosion inhibitors.

END OF SECTION 23 0591

SECTION 23 0592 - STEAM AND CONDENSATE SYSTEM STARTUP

GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Steam System Shutdown
 - 2. Steam System Startup
 - 3. System Blowdown after Startup or Shutdown
- B. Specified elsewhere:
 - 1. Section 23 2213 - Steam and Condensate Piping

1.03 QUALITY CONTROL

- A. Notify the Using Agency and the Owner/Engineer a minimum of 72 hours in advance and make all arrangements for the presence of Owner

1.04 TRAINING

- A. Contractor shall provide training on the operation and maintenance of all systems he has installed.
- B. Contractor shall present all training materials and course content to Engineer for approval prior to conducting any training.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 CLEANING OF PIPE SYSTEMS

- A. Clean piping prior to final test. See Section 23 2213 - Steam and Condensate Piping

3.02 TESTING

- A. It is mandatory that prior to start-up, the system shall be inspected to the extent necessary to assure compliance with the engineering design and with the material, fabrication, test and assembly requirements.

- B. Notify the Owner/Engineer and the user 72 hours in advance of actual testing, except that the preliminary hydraulic test as outlined below may be completed.
- C. Portions of the line shall be water tested as sections are installed. Correct all errors immediately.
- D. The testing shall be performed before any joints are insulated.

3.03 TEST MEDIA

- A. Preliminary Test:
 - 1. Hydraulic
 - 2. Vacuum test will not be permitted since vacuum does not test for proper thrust.
- B. Final Test:
 - 1. Hydraulic
 - 2. Steam test

3.04 TEST PREPARATION

- A. If test pressures are to exceed operating pressures, check to make sure that all thrust blocking is adequate for the test pressure.
- B. Equipment which is not to be subjected to the pressure test shall be either disconnected or isolated. Valves may be used provided that the valve including the closing mechanism is suited for the proposed test procedure.
- C. A joint which has been tested and covered need not be retested on conducting a subsequent test. Test pressures should not exceed the pressure limits of any equipment in the line and included in the test.

3.05 LEAKAGE TESTING

- A. Tests shall be performed and approval of tests obtained in writing prior to cleaning, backfilling, insulating, painting, or concealing.
- B. Prepare and keep records of each system or section of system tested. Test reports shall be signed as approved by user and transmitted to Owner/Engineer with one copy to user. If additional copies are required by those persons having legal jurisdiction, Contractor shall furnish them. Test reports shall include, but not necessarily be limited to, the following:
 - 1. Identification of piping system or section tested.
 - 2. Date of test and date of user's approval signature.
 - 3. Testing medium, test equipment description (sketch if necessary) and method of description of test procedure.
 - 4. Test pressure, duration of test, and recorded pressure drop.
- C. Pressurized Hydraulic Tests: WARNING; Hydraulic tests are very dangerous and should be used only with the greatest caution.
 - 1. A preliminary test at a pressure not exceeding 10 psig is recommended to locate major leaks.

2. Vent all air from system. Install manual air vents as require to test sections of piping.
3. Test sections at 225 psig with water, leaving all joints visible, i.e. not covered by insulation. Maintain test for a minimum of two hours.
4. Other requirements as requested by user.
5. Preliminary low pressure hydraulic tests as well as full pressure tests must be witnessed by user. Test at 150% maximum operating pressure.

3.06 STEAM LINE START-UP PROCEDURE

- A. Open free blow valves on all traps and take precautions to keep personnel clear of these areas for at least one hour or for whatever time is required to achieve “dry” free blow. NOTE: Large steam lines (8” - 14”) shall be provided with 1-inch bypass lines around the isolation valves because a slightly opened 8-inch valve may inadvertently allow too much steam into the system. All 6-inch, 8-inch, 10-inch, 12-inch valves, and 14-inch valves should be brought up in pressure by using 1-inch bypass lines around each valve and these large butterfly valves should not be opened until the system has reached operating pressures.
- B. Crack steam valves as noted above, allowing free blow from all traps. Maintain constant surveillance on the system, allowing no greater than a 15 psig pressure buildup on the system during this free blow period. At the end of one hour, check all free blow points to see if “sputter free” steam has been achieved. If insufficient time has elapsed to achieve a “dry” free blow, continue at 15 psig until such time as the “sputtering” has stopped, at which time all free blow valves should be closed.
- C. Allow steam pressure to climb to a maximum of 30 psig (approximately 275°F (135°C)) and remain at or near this pressure level for a minimum period of 24 hours.
- D. System can now be brought to operational levels at a rate of an additional 50 psig per hour.

3.07 SHUT DOWN

- A. Shut off main and bypass valves to the piping system.
- B. Crack all free blow valves at each trap, expelling all built-up condensate. As soon as “dry” steam is obtained at each trap point, the free blow valve shall be closed slowly as is each valve on either side of the trap. NOTE: It is the goal of this procedure to shut off the system with some positive dry steam pressure in the system and allow it to cool at its own shut-in cooling rate, thereby producing a rarified air or vacuum condition in the piping during down time. It is hoped that this procedure will minimize the corrosion problems normally encountered in steam lines during down time. If the system is “opened up” for repairs and is subsequently steam tested, it is recommended that a full start-up procedure (3.01) be used for testing, as well as a full shut-down procedure (3.02).

3.08 SUBSEQUENT START-UPS

- A. The same procedures shall be used as indicated in 3.06.

END OF SECTION

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SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - c. Multizone systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - 3. Balancing steam systems.
 - 4. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Chillers.
 - d. Cooling towers.
 - e. Condensing units.
 - f. Boilers.
 - g. Heat-transfer coils.
 - 5. Testing, adjusting, and balancing existing systems and equipment.
 - 6. Sound tests.
 - 7. Vibration tests.
 - 8. Duct leakage tests.
 - 9. Control system verification.

1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

- G. TDH: Total dynamic head.

1.04 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project Site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.05 ACTION SUBMITTALS

- A. LEED Submittals:
 - 1. Air-Balance Report for Prerequisite IEQ 1: Documentation indicating that work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - 2. TAB Report for Prerequisite EA 2: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 INFORMATIONAL SUBMITTALS

- A. Coordinate timing of informational submittals duration after Contractor's Notice to Proceed with overall project schedule to not delay delivery of the TAB scope of work
- B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- C. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- D. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- G. Certified Testing of Existing systems reports.
- H. Certified TAB reports.
- I. Sample report forms.
- J. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.

3. Application.
4. Dates of use.
5. Dates of calibration.

1.07 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.
 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
 2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.08 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:

- a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", which meets or exceeds requirements in ASHRAE 111 and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" 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 Section 23 3300 "Air Duct Accessories."
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 0713 "Duct Insulation," Section 23 0716 "HVAC Equipment Insulation," and Section 23 0719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 23 3113 "Metal Ducts."

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.

- b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
- a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
- a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.

- e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
- f. Verify tracking between supply and return fans.

3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.08 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- G. Verify that memory stops have been set.

3.09 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
1. Verify that the differential-pressure sensor is located as indicated.
 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

- 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 6. Prior to verifying final system conditions, determine the system differential-pressure set point.
 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
 10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:

- 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.10 PROCEDURES FOR HEAT EXCHANGERS

- A. Adjust water flow to within specified tolerances.
- B. Measure inlet and outlet water temperatures.
- C. Measure inlet steam pressure.
- D. Check settings and operation of safety and relief valves. Record settings.

3.11 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Airflow.
 - 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.13 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.14 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform preliminary testing of systems that are currently in place and whose capacities are expanded to meet the build out scope. Systems and equipment in this category include:
 1. [INPUT SYSTEM TYPES, DESCRIPTION OR TAGS]
- B. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Check the condition of coils.
 4. Check the operation of the drain pan and condensate-drain trap.
 5. Check bearings and other lubricated parts for proper lubrication.
 6. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- C. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- D. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

3.16 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent. Total air delivery rates per control thermal zone shall be plus or minus 5 percent.
 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.

- g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.

- i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- J. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.

- k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
 - M. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.
- 3.19 VERIFICATION OF TAB REPORT
- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
 - B. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
 - E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner, design professional or Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 0712 - HVAC INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. Section includes insulating the following HVAC duct, piping and equipment.
 - 1. Ducts Systems:
 - a. Supply Air Ducts
 - b. Outside Air Ducts
 - c. Exhaust Air Ducts
 - 2. Piping Systems:
 - a. Condensate Drain piping
 - b. Heating Water
 - c. Chilled Water
- B. Related Sections:
 - 1. Division 22 Section - Plumbing Insulation
 - 2. Division 23 Section - Hydronic Piping.
 - 3. Division 23 Section - Hangers and Supports for thermal inserts.
 - 4. Division 23 Section - Metal Ducts.

1.03 REFERENCE STANDARDS

- A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.
- B. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- C. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2004.
- D. ASTM C 534/C 534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2008.
- E. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2007.
- F. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 1990 (Reapproved 2004).

- G. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2007.
- H. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.
- I. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.
- J. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.
- K. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- L. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Jacket Material for Pipe: 12 inches long by NPS 2.
 - 3. Sheet Form Insulation Materials: 12 inchessquare.
 - 4. Sheet Jacket Materials: 12 inches square.
 - 5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Deliver material to site in factory fabricated containers with manufacturer's stamp or label, showing fire and smoke hazard ratings of products.
- C. Store material in original wrappings and protect from weather and construction traffic.
- D. Protect against sun, dirt, water, chemical and mechanical damage.
- E. Remove damaged insulation from project site. Do not install.

1.08 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

1.09 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 0529 "Hangers and Supports for HVAC."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork, piping and equipment Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.10 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

2.01 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK vapor barrier type jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Mansville: Microlite.
 - b. Knauf Insulation: Friendly Feel Duct Wrap.
 - c. Owens Corning: SOFTR All-Service Duct Wrap
 - 2. 'K Value: ASTM C 177, 0.22 at 75 deg F.
 - 3. Maximum service temperature: 850 deg F.
 - 4. Maximum moisture absorption: 0.2 percent by volume.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ for equipment insulation applications and with factory-applied FSK jacket for duct insulation applications. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Mansville: 800 Series Spin-Glas.
 - b. Knauf Insulation: Insulation Board.
 - c. Owens Corning: Fiberglass 700 Series.
 - 2. 'K Value: ASTM C 177, 0.22 at 75 deg F.
 - 3. Maximum service temperature: 850 deg F.
 - 4. Maximum moisture absorption: 0.2 percent by volume.

2.02 REMOVABLE/REUSABLE INSULATION SYSTEMS:

- A. Products: Subject to compliance with requirements, provide products by:
 - 1. ThermaXX Jackets, LLC
- B. Box Type Jackets: High-temperature hydrophobic insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting with maximum use temperature of 1200 deg F.
- C. Non Box Type Jackets: Glass mat, Type E needled fiber. 1/4", 1/2" at 9 lb/cf & 1" at 11.3 lb/cf with maximum use temperature of 1200 deg F.
- D. Jacket Systems, both pipe side and exterior side: PTFE fiberglass composite jacketing, 16.5 oz/sq. yd. minimum density with maximum use temperature of 600 deg F.
- E. Thread: Non-melting to 800 deg F, 0.0114 inch thick, 35 lb breakage point tensile strength.
- F. Construction:
 - 1. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching using thread in section 1.3D. The thread must be able to withstand the skin temperatures without degradation.
 - 2. Hog rings, staples and wire are not acceptable methods of closure.
 - 3. No raw cut jacket edges shall be exposed.
 - 4. Jackets shall be fastened using hook and loop (Velcro) straps and 1" Slide Buckles.
 - 5. Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
 - 6. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
 - 7. The insulation shall be designed to prevent sweating in the space between the cold metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
 - 8. All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric and shall be secured using hook & loop closure (i.e. Velcro TM) parallel to the seam.
 - 9. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.
- G. Jacket performance and insulation thickness shall meet or exceed that required as specified for the piping associated piping system.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand Specialty Construction Brands, Incl, a business of H.B. Fuller Company: CP-127
 - b. Eagles Bridges - Marathon Industries; 225.
 - c. Mon-Eco Industries, Inc.: 22-25

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand Specialty Construction Brands, Incl, a business of H.B. Fuller Company: CP-82
 - b. Eagles Bridges - Marathon Industries; 225.
 - c. Mon-Eco Industries, Inc.: 22-25
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. 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 Mansville: Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C Plastics, Inc.: Welding Adhesive.
 - d. Speedline Corporation: Polycy VP Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company: 30-03/11-90.
 - b. Vimasco Corporation: 749.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.

- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below 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 Company: CP-30
 - b. Eagle Bridges - Marathon Industries: 501.
 - c. Mon-Eco Industries, Inc.: 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. 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, Specialty Construction Brands, Inc., a business of H.B. Fuller Company: Encacel.
 - b. Eagle Bridges - Marathon Industries: 570.
 - c. Mon-Eco Industries, Inc.: 55-70.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mildry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.
- E. 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 Company: CP-10.
 - b. Eagle Bridges - Marathon Industries: 550.
 - c. Mon-Eco Industries, Inc.: 55-50.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.
 - 5. Color: White.

2.05 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 Company: CP-76.
 - b. Eagle Bridges - Marathon Industries: 405
 - c. Mon-Eco Industries, Inc.: 44-05
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: Aluminum.
 - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 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 Company: 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 deg F.
 5. Color: White.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Mansville; Zeston.
 - b. P.I.C Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: Color-code jackets based on system. Color as selected by Architect.

4. Factory- fabricated fitting covers to match jacket if available; otherwise, field fabricate:
 - a. Shapes: 45- and 90-degree, short- and long radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Compac Corporation; 104 and 105.
 - c. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Compac Corporation; 110 and 111.
 - c. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch width.

2.09 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, provide one of the following:

- a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
 - B. Insulation Pins and Hangers:
 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CHP-1
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Nelson Stud Welding; CHP
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150
 - 2) GEMCO; R-150
 - 3) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - C. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
 - D. Wire: 0.062-inch soft-annealed, stainless steel.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C&F Wire.
 - b. Childers Products.
 - c. RPR Products, Inc.
- 2.10 CORNER ANGLES
- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
 - B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
 - C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):
Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Section 07 8413 "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- F. Butt insulation and seal joints and breaks with vapor barrier tape or sealer and 2 inches of foil adhered over joint.
- G. Inserts and Shields:
 - 1. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 2. Insert location: Between support shield and piping and under the finish jacket.
 - 3. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 4. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- I. Exposed piping in Mechanical Equipment Rooms or unfinished spaces less than 7 feet above finished floor: Provide with aluminum jacket.
- J. Exposed piping in Public Spaces: Provide with PVC jacket and fitting covers.

- K. Insulate all exposed piping, including thermostatic mixing valves, below fixtures scheduled for use by the disabled in accordance with ADA.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- M. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- N. Install removable insulation covers at strainers, flanges, unions, pumps and other items requiring service access. Installation shall conform to the following.

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

- b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface.
Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface.
Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and

- inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. Insulation Installation on Straight Pipes and Tubes.
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- D. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- E. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- F. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application
- G. Mineral-fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

- H. Mineral fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2 inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 FINISHES

- A. Exposed Duct, Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

- D. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule, General" Article.
 - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, two locations of threaded fittings, two locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, two locations of threaded valves, and two locations of flanged valves for each pipe service identified in the "Piping Insulation Schedule, General" Article.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, supply and outdoor air.
 - 2. Indoor, return located in unconditioned space.
 - 3. Indoor, exhaust duct systems serving ironer and dryers
- B. Items Not Insulated:
 - 1. Factory-insulated flexible ducts.
 - 2. Factory-insulated plenums and casings.
 - 3. Flexible connectors.
 - 4. Vibration-control devices.
 - 5. Factory-insulated access panels and doors.
 - 6. Ducts located outdoors and conveying unconditioned outdoor-air.
 - 7. Ducts located outdoors and conveying exhaust-air

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Duct Liner Prohibition - Insulation specified below is exterior to all metal duct system. The terms Mineral-Fiber Blanket and Mineral-Fiber Board shall not be construed to refer to any type of Interior Duct Liner system.
- B. Supply-air ducts in exposed ceilings in finished spaces other than mechanical rooms shall be double wall ductwork; Specified under Division 23 Section "Metal Ducts".

- C. Supply-air duct and plenum insulation in concealed locations, shafts, and exposed in mechanical rooms shall be one of the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- D. Outdoor-air duct and plenum insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket (Permitted on round and oval ducts only): 2 inches thick and 0.75-lb/cu. ft. nominal density
 - 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- E. Exhaust-air duct and plenum insulation from 24 inches in board of the isolation damper to the penetration of building exterior shall be one of the following or within 10 feet of building exterior, whichever distance is greater:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- F. Outdoor air intake plenum: Fire-rated blanket or board; thicknesses, overlaps, banding and protected (where exposed) as required to achieve 2-hour fire rating.

3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water from cooling coils, all pipe sizes:
 - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- B. Chilled water piping: All sizes.
 - 1. Flexible Elastomeric: Two layers 3/4 inch thick each for total 1-1/2 inches thick
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
- C. Heating Water piping:
 - 1. NPS 1-1/2 and Smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
 - 2. NPS 2 and Larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Lower Pressure Steam and Condensate Piping, 15 psig and less:
 - 1. NPS 1-1/2 and Smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 2-1/2 inches thick.
 - 2. NPS 2 and Larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
- E. Gravity and Pumped Steam Condensate:

1. NPS 1-1/2 and Smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 2-1/2 inches thick.
 2. NPS 2 and Larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
- F. Medium Pressure Steam and Condensate Piping, (above 15 psig, but not exceeding 100 psig)
1. NPS 1/2 to NPS 3/4: Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
 2. NPS 1 to NPS 1-1/4: Mineral-Fiber, Preformed Pipe Insulation, Type I: 4 inches thick.
 3. NPS 1-1/2 and Larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 4-1/2 inches thick.
- G. High Pressure Steam and Condensate Piping, (above 100 psig):
1. NPS 1/2 to NPS 3/4: Mineral-Fiber, Preformed Pipe Insulation, Type I: 4-1/2 inches thick.
 2. NPS 1 and Larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 5 inches thick.

END OF SECTION

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SECTION 23 0800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 019100 Section "General Commissioning Requirements" for commissioning process requirements.

1.03 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. Contractor: Contractor: May refer to project General Contractor, Mechanical Contractor, Electrical Contractor, or subcontractors thereof depending on the context with which it is used.
- C. CxA: Commissioning Authority.
- D. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- E. IOM Manual: Installation, Operation and Maintenance Manual
- F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Upload Requested Information to Commissioning Website including but not limited to Submittals, Performance Data, Capacity Information, Sequences of Operation, Factory Performance Tests, and IOM Manuals. If electronic versions are not available CxA, at the contractor's option, may elect to upload information on behalf of the contractor for a nominal administration fee.
- B. Complete electronic Pre-Functional Checklists (PFCs) under the direction of the CxA using either a computer with internet connection or application based tablet. Mobile devices must be synchronized nightly with the internet.
- C. Perform Functional Performance Testing (PFTs) at the direction of the CxA.

- D. Respond to issues generated by the Commissioning Agent using the commissioning website. Issues are to be responded to using the website commissioning tool, fax and email responses are not acceptable. After issues are generated by the CxA and assigned to contractor, contractor is to log into the website, change the issue from “open” to “addressed” and provide a brief description on how the issue has been addressed.
- E. Attend construction phase controls coordination meeting.
- F. Attend Fire Alarm and Smoke Control coordination meeting.
- G. Attend testing, adjusting, and balancing review and coordination meeting.
- H. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- I. Provide information requested by the CxA for final commissioning documentation.

1.05 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Review “Filtered” Requests for Information (RFIs) as they pertain to commissioned systems.
- C. Review Contractor’s submittals.
- D. Direct commissioning Functional Performance Testing.
- E. Verify testing, adjusting, and balancing of Work are complete.
- F. Verify and Document training occurred per the contract requirements.
- G. Provide test data, inspection reports, and certificates in Systems Manual.

1.06 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.07 SUBMITTALS

- A. In addition to standard product submittals and shop drawings as defined in project specification sections Divisions 22, 23 and 26, contractor may be required to fill out and sign off on commissioning agent system readiness matrix at the discretion of the commissioning agent. System readiness matrix will list all MEP building systems and ask for written confirmation that systems are complete and ready for functional testing. If required, system readiness matrix will be produced and provided to contractor by commissioning agent.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, equipment and controls have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, upload copies of reports, sample forms, checklists, and certificates to the commissioning website.
- B. Notify the CxA at least Fifteen (15) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If major problems are discovered during the test, the responsible subcontractors and General Contractor will fix the problem and the test shall be redone. If more than two functional performance tests are required, the responsible subcontractor will be back-charged for the CxA's time and expenses.
- K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. HVAC Systems: Test all modes of operation, including occupied/unoccupied, start-up, shut down, failure, emergency, capacity, modulation, performance, and consistency tests - expected duration to be 3 days of hands on tests. This does not include setup, preparation recording, or data downloading time.
- B. HVAC Smoke Control: Test all modes of operation, including normal, emergency, restore and consistency tests - expected duration to be 1 day of hands on tests. This does not include setup, preparation recording, or data downloading time.
- C. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 22 and/or Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- D. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- E. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hot water and chilled water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- G. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

END OF SECTION 23 0800

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SECTION 23 0920 - CONTROL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. DDC System for monitoring and controlling of HVAC systems including:
 - a. System Architecture
 - b. Controllers
 - c. Sensors and Input Devices
 - d. Output Devices
 - e. Power Supplies and Transformers
 - f. Actuators
 - g. Control Dampers
 - h. Control Valves
 - i. Low Voltage Cable
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

1.03 REFERENCES

- A. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning
- B. ASME MC85.1 - Terminology for Automatic Control
- C. NEMA EMC1 - Energy Management Systems Definition
- D. NFPA 70 - National Electric Code
- E. NFPA 90A - Air Condition systems
- F. NFPA 101 - Life Safety Code

1.04 SYSTEM DESCRIPTION

- A. Provide a fully integrated Building Automation System (BAS) incorporating the components herein specified and indicated on the drawings. System shall include electric and electronic components to provide a complete functioning Direct Digital Control System.
- B. All materials and equipment shall be standard components regularly manufactured for this and/or other systems. All components shall be thoroughly tested and proven in actual use.

- C. The BAS system shall provide automatic decision-making and control for building heating, ventilating and air conditioning (HVAC) along with other functions.
- D. The existing facility has a BAS based on Honeywell platform and a maintenance contract with Harris Company, Controls Division. All controls and instrumentation shall be Honeywell equipment and completely compatible with the existing systems. All programming methodologies and communication protocols shall be identical to the existing campus standards established by the BAS vendor, Harris Company. For assistance contact:
Jarvis Hofhines, General Manager, Controls Division, Harris.
1193 West 2200 South, Suite A, Salt Lake City, UT 84119
D: (801) 433.2781
O: (801) 956-046
M: (801) 673-4631
E: jhofhines@harriscompany.com

1.05 SCOPE

- A. Provide, assemble, mount, and wire all devices and system components.
- B. Assist the Balancing Contractor and Commissioning Agent
- C. Facilitate and perform the complete checkout of the entire system, verifying proper operation in accordance with design specifications.

1.06 PROGRAMMING

- A. To be completed by the control contractors.

1.07 COORDINATION

- A. The following incidental work shall be furnished by the designated contractor under supervision of the Controls Contractor. The Controls Contractor shall provide all required information, materials, direction, and training to the designated contractor as required to provide a complete working system.
- B. The General Contractor shall:
 - 1. Provide access doors or other approved means of access in concealed ceiling and walls for service of control equipment.
 - 2. Provide all necessary cutting, patching and painting.
- C. The Mechanical Contractor shall:
 - 1. Install control valves and sensor wells that are provided by the controls contractor.
 - 2. Provide necessary valved pressure taps, water, drain and overflow connections and piping.
 - 3. Install automatic dampers, required interconnection linkages and extend damper shafts as necessary for mounting of actuators
 - 4. Provide access doors or other approved means of access in ductwork for service of control equipment.
- D. The Electrical Contractor shall:

1. Provide auxiliary contacts, buttons and switches on all starters as required
 2. Provide power wiring (120V or greater) to control panels, motor starters, variable frequency drives, motors, electric actuators, electric devices and smoke detectors.
- E. Control Contractor shall provide Programming Services
1. Define BAS software programming to accomplish sequence of operation per the project specification and drawings. Load the software program into the electronic devices.
 2. Provide software program to the Controls Contractor.
 3. Provide program documentation to Controls Contractor.
 4. Incorporate final redline changes from contractor record drawings.
 5. Provide electronic graphics for the building automation system.
 6. Update system global files.

1.08 SUBMITTALS FOR REVIEW

- A. Clearly note the proposed deviations from specified sequences and equipment, and substantiate with written explanation.
- B. Shop Drawings and Equipment Product Data:
1. Manufacturer's printed data sheets for all control system components clearly identify data by component.
 2. General catalog sheets, including details of construction, ratings, and dimensions for each component.
 3. Show complete details of interconnections between temperature control systems and controls specified with equipment or systems.
 4. Provide Valve Schedules indicating size, type, design flow, valve capacity, pressure drop and CV value, identification and part number.
 5. Provide Dampers Schedule indicating dimension and descriptions of blank-offs, installation location, damper features, identification and part number.
 6. Shop Drawings and Product Data are not required for BAS panels or specific parts included in the bill of materials in panel drawings.

1.09 SUBMITTALS AT CLOSEOUT

- A. Section 017700 "Closeout Submittals" - Contract Closeout; Procedures for maintenance documents and submittals.
- B. Project Record Documents: Maintain documents at site during construction and submit at Contract Closeout.
- C. Operation and Maintenance Data Include:
1. Red-mark "Record" control system drawings and then turn them over to the Owner's Representative.
 2. Provide directions for calibration, adjustment and maintenance instructions for each type of component.
 3. Complete Index of Contents
 4. Shop drawings of control system showing devices, interconnections between devices, and connections to items provided by others.
 5. Specifications data sheets on each device.

1.10 WARRANTY

- A. The scope of work included in this section shall be guaranteed to be free from original defects in both material and workmanship for the period as indicated in the contract terms.

PART 2 - PRODUCTS

2.01 SYSTEM ARCHITECTURE

- A. The BAS shall be provided with a Master Control Panel and shall function as the overall system coordinator and shall be capable of integrating multiple building functions including HVAC equipment supervision and control, building equipment monitoring, alarm management, energy management, information management, historical data, collection and archiving. The BAS shall consist of individual DDC Control Panels, Application Specific Controllers, and Local Display Devices.
- B. The system architecture shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Control Panel shall operate independently from all other control components and will maintain control strategies when other components in system fail.
- C. Communication networks between control panels shall be made without the need for a central processing controller.

2.02 CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
- F. Network Control Unit
 - 1. PXC Bacnet Controller or approved equal. All equipment shall be compatible with this version.
- G. Application Specific Controller
 - 1. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

- a. Capable of standalone operation and shall continue to include control functions without being connected to network.
 - b. Data shall be shared between networked controllers and other network devices.
2. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
3. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
4. Serviceability:
 - a. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 - b. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - c. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.
 - d. Include manufacturer's logic to perform automatic calibration of terminal units at regularly scheduled intervals.

H. Local Control Panels

1. All control panels shall be factory constructed, incorporating the FMS manufacturers standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL508a label listing compliance. Control panels shall be fully enclosed, with sub-panel, hinged door, and slotted flush latch. All Controls components within panels or elsewhere shall be UL 508 listed.
2. In general, the control panels shall consist of the DDC controller(s), display module, and I/O devices-such as relays, transducers, and so forth-that are not required to be located external to the control panel due to function. The display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be extended to a numbered, color-coded, and labeled terminal strip for ease of maintenance and expansion. Wiring to I/O devices shall be made from this terminal strip.
4. All other wiring in the panel, internal and external, shall be made to additional line or low voltage color-coded and labeled terminal strips. Low and line voltage wiring shall be segregated. All terminal strips and wiring shall be UL listed 300-volt service and provide adequate clearance for field wiring.
5. All wiring for every control panel shall follow a common color-coded format. All terminal strip color coding and numbering shall follow a common format. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle, fused on/off power switch, and required transformers shall be provided in each enclosure.

2.03 SENSORS AND INPUT DEVICES

A. Temperature Sensors (Building)

1. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
2. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

3. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
 - a.

<u>Point Type</u>	<u>Accuracy</u>
b. Chilled Water	+ .5°F.
c. Room Temp	+ .5°F.
d. Duct Temperature	+ .5°F.
 4. Room sensors shall be constructed for either surface or wallbox mounting.
 5. Room sensors shall have the following options when specified:
 - a. Setpoint reset slide switch providing a +3 degree (adjustable) range.
 - b. Individual heating/cooling setpoint slide switches.
 - c. A momentary override request push button for activation of after-hours operation.
 - d. Analog thermometer.
 - e. 1000 ohm thin film nickel sensor
 - f. Acceptable manufacturers: Honeywell
- B. Room Pressure Sensors
1. Room sensors shall be constructed for either surface or wall box mounting.
 2. Room sensors shall have the following options when specified:
 - a. Display option: LED pressure display.
 - b. Pressure Ranges: Jumper Selectable.
 - c. Mode: Unidirectional or Bidirectional, Jumper-selectable. Output Field Selectable: 2-wire, loop-powered 4-20mA, or 3-wire 05V/0-10V.
 - d. Input power 24VAC/DC nominal.
 - e. Acceptable manufacturers: Veris Industries, model PLX01S
- C. Room Temperature Sensors with Integral Display
1. Room sensors shall be constructed for either surface or wallbox mounting.
 2. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - a. Display room and outside air temperatures.
 - b. Display and adjust room comfort setpoint.
 - c. Display and adjust fan operation status.
 - d. Timed override request push button with LED status for activation of after-hours operation.
 - e. Display controller mode.
 - f. Password selectable adjustment of setpoint and override modes.
- D. Averaging Sensors
1. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification may exist, an averaging sensor with multiple sensing points shall be used.
 2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 3. Capillary supports at the sides of the duct shall be provided to support the sensing string.
- E. Pressure Transmitters
1. General Air and Water Pressure Transmitter Requirements:

- a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 ma output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - e. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - f. Acceptable manufactures: Mamac
- 2. Low Differential Water Pressure Applications (0" - 20" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 ma output in response to variation of flow meter differential pressure or water pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) .01-20" w.c. input differential pressure range.
 - 2) 4-20 ma output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - c. Acceptable manufactures: Mamac
- 3. Low Differential Air Pressure Applications (0" to 5" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 ma output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - 2) 4-20 ma output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - c. Acceptable manufactures: Mamac
- F. Thermal Dispersion Airflow Measurement:
 - 1. Thermal dispersion airflow measurement devices shall be manufactured by Ebtron, Inc
 - 2. All electronic thermal dispersion airflow measurement devices shall be compatible with Siemens systems.

3. Thermal dispersion airflow/temperature measurement devices (ATMD) shall be suitable for volumetric air flow rate tracking. ATMD shall mount in fan inlet throat (Ebtron GTE116-F) or in duct (Ebtron GTE116-PD).
4. This shall be a complete system, consisting of sensor probe, transmitter, and enclosure, interconnecting wiring cable, and 10 BaseT Ethernet option for full duplex communication using BACnet, Ethernet, BACnet IP, Modbus TCP, or TCP/IP protocols and operation with any BAS.
5. Sensor construction shall consist of two bead-in-glass thermistors in a GFP sensor housing sealed with marine grade epoxy. Mounting brackets shall be stainless steel. Duct mounted sensors shall be averaging type.
 - a. Calibrated Range: 0 to 10,000 fpm [50.8 m/s]
 - b. Operating Temperature: Probe: -20 to 160°F
 - c. Transmitter: -20 to 120°F
 - d. Operating Humidity Range: .0 to 99% non-condensing;
 - e. Power Requirements: 24 VAC (22.8-26.4 VAC) at 12-13.1VA (based on sensor quantity)
 - f. Transmitter Construction .Heavy duty with industrial grade IC's and rugged aluminum chassis with sliding cover
 - g. Sensor Construction: Two bead-in-glass thermistors in a GFP sensor housing sealed with waterproof marine grade epoxy.
 - h. Mounting Brackets: Type 304 stainless steel
 - i. Factory Calibrated Sensor Accuracy: Airflow: $\pm 2\%$ of reading, Temperature: $\pm 0.15^\circ\text{F}$ [$\pm 0.08^\circ\text{C}$]
 - j. Probe/Transmitter Cable: . .10 ft. [3.05 m] plenum rated FEP cable, positive locking connector with gold plated pins (Optional cable length to 50 feet [15.24m])
 - k. Analog Output: Isolated analog 0-5/0-10 VDC or 4- 20 mA, linear airflow/temperature
 - l. Analog Output Resolution: . .0.025% of full scale
 - m. RS-485 Output: Field selectable BACnet® MS/TP Master, Modbus RTU or JCI N2-Bus®
 - n. RS-485 Baud Rate: 9.6k, 19.2k, 38.4k, and 76.8k baud
 - o. Repeatability: 0.25% of reading
 - p. Field Calibration Wizard: . . .Automated 1 or 2 point adjustment to factory calibration
 - q. Airflow Output Signal Filter: .Field Adjustable 0 to 99% (via pushbutton interface)
 - r. Airflow Low Limit Cutoff: . . .Forces output to zero below a user-specified value
 - s. Programmable Alarm: Alarm can be engaged for user defined Hi or Low Limit, Setpoint with hysteresis for airflow or transmitter/probe fault conditions.

G. Power Monitoring Devices

1. Current measurement (Amps) shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 ma DDC compatible signal for use by the Facility Management System.
2. Current Transformer - A split core current transformer shall be provided to monitor motor amps.
 - a. Operating frequency - 50 - 400 Hz.
 - b. Insulation - 0.6 Kv class 10Kv BIL.

- c. UL recognized.
 - d. Five-amp secondary.
 - e. Select current ratio as appropriate for application.
 - f. Acceptable manufacturers: Veris Industries
- 3. Current Transducer - A current to voltage or current to ma transducer shall be provided. The current transducer shall include:
 - a. 6X input over amp rating for AC inrushes of up to 120 amps.
 - b. Manufactured to UL 1244.
 - c. Accuracy: +. 5%, Ripple +1%.
 - d. Minimum load resistance 30kOhm.
 - e. Input 0-20 Amps.
 - f. Output 4-20 ma.
 - g. Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
 - h. Acceptable manufacturers: Veris Industries

H. Status and Safety Switches

- 1. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
- 2. Current Sensing Switches
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries

2.04 OUTPUT DEVICES

A. Control Relays

- 1. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- 2. Mounting bases shall be snap-mount.
- 3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- 4. Contacts shall be rated for 10 amps at 120VAC.
- 5. Relays shall have an integral indicator light and check button.

2.05 POWER SUPPLIES AND TRANSFORMERS

A. DC Power Supplies

- 1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
- 2. Input: 120 VAC +10%, 60Hz.

3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

B. Transformers

1. Sized to provide volts and amps as required for connected load.
2. Input voltage shall be as required for the specific application.

2.06 ACTUATORS

A. Damper and valve actuators shall be electronic, as specified in the Sequence of Operation, Control Drawings and Wiring Diagrams.

B. Electronic Damper Actuators

1. Electronic damper actuators shall be direct shaft mount.
2. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction and a gear release to allow manual positioning.
3. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 ma, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
4. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
5. Acceptable manufacturers: Honeywell or approved equal.

C. Electronic Valve Actuators

1. Electronic valve actuators shall be manufactured by the valve manufacturer.
2. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
3. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be

sized based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

4. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 ma and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
5. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
6. Acceptable manufacturers: Honeywell or approved equal.

2.07 CONTROL DAMPERS

- A. Performance: Test in accordance with AMCA 500.
- B. All automatic dampers shall be sized for the application or as specifically indicated on the Drawings.
- C. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- D. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- E. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48". Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be provided for any section exceeding 48" in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.5 cfm per square foot when closed against 4" w.c. static pressure when tested in accordance with AMCA Std. 500.
- F. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.c., but no more than 4000 FPM or 6" w.c.
- G. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

- H. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.
- I. Acceptable manufacturers are: Ruskin CD-50, or approved equal.

2.08 CONTROL VALVES

- A. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule.
- B. Heating and chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
- C. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.
- D. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
- E. Acceptable manufacturers: Honeywell or approved equal.

2.09 Low voltage cable

- A. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC and General Purpose Cabling.
 - 1. Cable shall consist of copper conductors not less No. 18 AWG-stranded.
 - 2. Shall be 2 or 3 conductor twisted cable with a drain wire.
 - 3. Cable shall have a 100% overall shield.
 - 4. Cable shall be a plenum-rated.
 - 5. Cable shall meet or exceed NEC voltage rating of 300V.

6. Cable shall be NEC type CMP.
 7. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 8. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name and the type of signal carried within the cable, i.e. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC.
 9. Each of the cable types specified in Item A shall be of a different color coding for easy identification and troubleshooting. Required color coding:
 - a. Analog Input Cable: Yellow
 - b. Analog Output Cable: Tan
 - c. Binary Input Cable: Orange
 - d. Binary Output Cable: Violet
 - e. 24 VAC Cable: Gray
 - f. General Purpose Cable: Natural
- B. Primary and Secondary Communications Network Cabling.
1. Cable shall be of type recommend by the DDC System Manufacturer.
 2. Cable shall be shielded.
 3. Cable shall be a plenum-rated.
 4. Cable shall meet or exceed NEC voltage rating of 150V.
 5. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 6. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name, system name and the communications network name.
 7. Each of the cable types shall be of a different color-coding for easy identification and troubleshooting and shall be of a different color than the cable specified in Item A above.
- C. Room Sensor Cabling
1. Cable shall consist of copper conductors not less No. 24 AWG.
 2. Shall be multi-paired (at least two pairs) twisted cable.
 3. Cable shall have a 100% overall shield.
 4. Cable shall be a plenum-rated.
 5. Cable shall meet or exceed NEC voltage rating of 300V.
 6. Cable shall be NEC type Article 800-CMP.
 7. Cable shall meet or exceed UL temperature rating of +75 degrees C.
 8. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name and labeled as a stat cable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Completely install automatic temperature control system as specified.
- B. Coordinate installation of devices, wiring, and other items with other trades.
- C. Locate thermostat/sensors where they will not be affected by heat from other sources, such as direct rays of sun, pipes or ducts in wall, convectors, direct air currents from diffusers, light dimmers and similar items.

- D. Coordinate locations of space temperature sensors as indicated or approved by owner representative.
- E. Low temperature protection thermostat shall be located upstream of the cooling coil. The entire duct area shall be covered to detect low air temperature due to stratification.
- F. Current sensing relay trip levels shall be set to indicate the motor running under load vs. no load.
- G. Verify wiring terminations at all devices and correct as required. Provide identification label for each termination.

3.02 START-UP SERVICES

- A. Verify proper location of each device and point-to-point BAS integrity, correct as needed.
- B. When installation is complete and automatic control system is placed in operation, adjust and calibrate all instruments and devices in system and ensure that system is operating in accord with specified sequences.
- C. Diagnose component and system problems. Communicate irregularities to the appropriate contractor for correction.
- D. Attend construction meetings as required to coordinate with other contractors and provide input during problem resolution.

3.03 SENSORS AND INPUT DEVICES

- A. All Input devices shall be installed per the manufacturer's recommendation.
- B. Space Temperature Sensors: Shall be mounted 42-50" above the finished floor unless otherwise noted on Mechanical or Architectural Sheets.
- C. Duct Mount Sensors
 - 1. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - 2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - 3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3.04 OUTPUT DEVICES

- A. All output devices shall be installed per the manufacturer recommendation.

3.05 WIRING

- A. Install wiring in accordance with National Electric Code; ANSI/NFPA 70.

- B. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures. For concealed and accessible areas, plenum rated wiring and cabling may be used.
- C. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.
- D. Low voltage control wiring and 24VAC can be run in the same conduit. Power wiring 120VAC and greater must be in a separate conduit.
- E. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors or expansion shields. All-purpose plastic anchors are not acceptable.
- F. Control panels shall be mounted on vibration free walls or freestanding structural supports. Panels shall be located as indicated or approved by owner representative.
- G. Locate circuits, relays, transformers or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.
- H. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size 3/4".
- I. All devices located in pool area to be rated for pool environment. All exposed conduits in pool area to be aluminum or water tight flexible conduit. All recessed or in slab conduit in pool area to be PVC.

3.06 IDENTIFICATION STANDARDS

- A. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.
- B. Controller Identification: All controllers shall be identified by typed (not handwritten) securely attached tag label.
- C. Panel Identification: All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
- D. Panel Devices: All panel devices shall be identified by a typed label securely fastened to the back plate of the local control panel.
- E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
- F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

END OF SECTION 23 0920

SECTION 23 0920.01 - CONTROL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. DDC System for monitoring and controlling of HVAC systems including:
 - a. System Architecture
 - b. Controllers
 - c. Sensors and Input Devices
 - d. Output Devices
 - e. Power Supplies and Transformers
 - f. Actuators
 - g. Control Dampers
 - h. Control Valves
 - i. Lighting Control Relays
 - j. Low Voltage Cable
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Related Requirements
 - 1. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC (Not Used)
 - 2. Division 23 Section - Commissioning of HVAC
 - 3. Section 23 3417 - Fan Array System
 - 4. Section 23 3610 - Critical Environment Air Terminal Units
 - 5. Section 23 5217 - Condensing Dual Fuel Hydronic Boilers
 - 6. Section 23 3300 - Air Duct Accessories
 - 7. Division 26 Section - Fire Detection and Alarm
 - 8. Division 26 Section - Electrical Rough-in for Low Voltage Systems
 - 9. Division 27 Section - Communications

1.03 REFERENCES

- A. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning
- B. ASME MC85.1 - Terminology for Automatic Control
- C. NEMA EMC1 - Energy Management Systems Definition
- D. NFPA 70 - National Electric Code

- E. NFPA 90A - Air Condition systems
- F. NFPA 101 - Life Safety Code

1.04 SYSTEM DESCRIPTION

- A. Memorial Hospital of Sweetwater County utilizes Honeywell Controls, furnished and installed by Harris Company. Include campus vendor in Base Bid. Alternative interested bidders shall submit substitution request in accordance with Division 01. Information "Requests for Prior Approval" will not be considered.
- B. All materials and equipment shall be standard components regularly manufactured for this and/or other systems. All components shall be thoroughly tested and proven in actual use.
- C. The BAS system shall provide automatic decision-making and control for building heating, ventilating and air conditioning (HVAC) along with other functions.

1.05 SCOPE

- A. Provide, assemble, mount, and wire all devices and system components.
- B. Assist the Balancing Contractor and Commissioning Agent
- C. Facilitate and perform the complete checkout of the entire system, verifying proper operation in accordance with design specifications.

1.06 PROGRAMMING

- A. To be completed by the control contractors.

1.07 COORDINATION

- A. The following incidental work shall be furnished by the designated contractor under supervision of the Controls Contractor. The Controls Contractor shall provide all required information, materials, direction, and training to the designated contractor as required to provide a complete working system.
- B. The General Contractor shall:
 - 1. Provide access doors or other approved means of access in concealed ceiling and walls for service of control equipment.
 - 2. Provide all necessary cutting, patching and painting.
- C. The Mechanical Contractor shall:
 - 1. Install control valves and sensor wells that are provided by the controls contractor.
 - 2. Provide necessary valved pressure taps, water, drain and overflow connections and piping.
 - 3. Install automatic dampers, required interconnection linkages and extend damper shafts as necessary for mounting of actuators
 - 4. Provide access doors or other approved means of access in ductwork for service of control equipment.

- D. The Electrical Contractor shall:
 - 1. Provide auxiliary contacts, buttons and switches on all starters as required
 - 2. Provide power wiring (120V or greater) to control panels, motor starters, variable frequency drives, motors, electric actuators, electric devices and smoke detectors.
- E. Control Contractor shall provide Programming Services
 - 1. Define BAS software programming to accomplish sequence of operation per the project specification and drawings. Load the software program into the electronic devices.
 - 2. Provide software program to the Controls Contractor.
 - 3. Provide program documentation to Controls Contractor.
 - 4. Incorporate final redline changes from contractor record drawings.
 - 5. Provide electronic graphics for the building automation system.
 - 6. Update system global files.

1.08 SUBMITTALS FOR REVIEW

- A. Section 013300 "Submittal Procedures".
- B. Clearly note the proposed deviations from specified sequences and equipment, and substantiate with written explanation.
- C. Shop Drawings and Equipment Product Data:
 - 1. Manufacturer's printed data sheets for all control system components clearly identify data by component.
 - 2. General catalog sheets, including details of construction, ratings, and dimensions for each component.
 - 3. Show complete details of interconnections between temperature control systems and controls specified with equipment or systems.
 - 4. Provide Valve Schedules indicating size, type, design flow, valve capacity, pressure drop and CV value, identification and part number.
 - 5. Provide Dampers Schedule indicating dimension and descriptions of blank-offs, installation location, damper features, identification and part number.
 - 6. Shop Drawings and Product Data are not required for BAS panels or specific parts included in the bill of materials in panel drawings.
 - 7. The Sequences provided in the document shall be reviewed by the Commissioning Agent and engineer prior to programming. The contractor shall accommodate adjustments to sequencing as dictated by the commissioning agent before programming commences.

1.09 SUBMITTALS AT CLOSEOUT

- A. Section 017700 "Closeout Submittals" - Contract Closeout; Procedures for maintenance documents and submittals.
- B. Project Record Documents: Maintain documents at site during construction and submit at Contract Closeout.
- C. Operation and Maintenance Data Include:
 - 1. Red-mark "Record" control system drawings and then turn them over to the Owner's Representative.

2. Provide directions for calibration, adjustment and maintenance instructions for each type of component.
3. Complete Index of Contents
4. Shop drawings of control system showing devices, interconnections between devices, and connections to items provided by others.
5. Specifications data sheets on each device.

1.10 WARRANTY

- A. The scope of work included in this section shall be guaranteed to be free from original defects in both material and workmanship for the period as indicated in the contract terms.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Eligibility Criteria:
 1. Subject to Geographic Limitation. Vendor shall have fully staffed office with Service Personnel, including Lead Programmer, within the State of Wyoming, within 100 miles of the Project Site, or ~~and~~ no more than 2 hours drive from Project Site during summer weather condition.
 2. All buildings shall be furnished with the same manufactured equipment. Separate BAS controls manufacturers from one building to another is explicitly prohibited.
 3. Owner's Staff Training for Enhanced Programming Capability. Eligible vendor shall demonstrate Owner training protocols including Factory Training, Self-Guided tutorials, and other means to allow Owner's staff to perform Coding.
 4. Eligible vendors shall not include any software licensing fees, subscription fees, or similar cost structures. Successful vendor acknowledges Contract constitutes outright purchase of software without renewal fees that includes automatic software updates and bug fixes without any additional cost.
 5. All interested Controls Vendors shall be subject to a Pre-Qualification process prior to the Bid Date. Submit Letter of Interest to Bid project in accordance with Division 01 Section 012500 Substitution Procedures. Include statement of qualifications indicating compliance with eligibility criteria, list of Campus systems in Project vicinity and surrounding territory, and contact information for three references from Facilities Manager, Physical Plant Manager, or Similar titled responsibility for Healthcare and/or Higher Education Campus settings.
 6. Subject to compliance with Project Requirements and Eligibility Criteria, available manufacturers may include:
 - a. Honeywell Controls, as furnished by Harris Company.
 - b. No pre-approved alternatives permitted. Alternative interested bidders shall submit substitution request in accordance with Division 01.
 7. All control system integration shall adhere to BACnet open protocol standards including programming language, not just information transfer amongst the devices.

2.02 SYSTEM ARCHITECTURE

- A. The BAS shall be provided with a Master Control Panel and shall function as the overall system coordinator and shall be capable of integrating multiple building functions including HVAC equipment supervision and control, building equipment monitoring, alarm management, energy management, information management, historical data, collection and archiving. The BAS shall consist of individual DDC Control Panels, Application Specific Controllers, and Local Display Devices.
- B. The system architecture shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Control Panel shall operate independently from all other control components and will maintain control strategies when other components in system fail.
- C. Communication networks between control panels shall be made without the need for a central processing controller.

2.03 CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
- F. Network Control Unit
 - 1. PXC Bacnet Controller or approved equal. All equipment shall be compatible with this version.
- G. Application Specific Controller
 - 1. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
 - a. Capable of standalone operation and shall continue to include control functions without being connected to network.
 - b. Data shall be shared between networked controllers and other network devices.
 - 2. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

3. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
4. Serviceability:
 - a. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 - b. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - c. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.
 - d. Include manufacturer's logic to perform automatic calibration of terminal units at regularly scheduled intervals.

H. Local Control Panels

1. All control panels shall be factory constructed, incorporating the FMS manufacturers standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL508a ~~UL-508~~ label listing compliance. Control panels shall be fully enclosed, with sub-panel, hinged door, and slotted flush latch. All Controls components within panels or elsewhere shall be UL 508 listed.
2. In general, the control panels shall consist of the DDC controller(s), display module, and I/O devices-such as relays, transducers, and so forth-that are not required to be located external to the control panel due to function. The display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be extended to a numbered, color-coded, and labeled terminal strip for ease of maintenance and expansion. Wiring to I/O devices shall be made from this terminal strip.
4. All other wiring in the panel, internal and external, shall be made to additional line or low voltage color-coded and labeled terminal strips. Low and line voltage wiring shall be segregated. All terminal strips and wiring shall be UL listed 300-volt service and provide adequate clearance for field wiring.
5. All wiring for every control panel shall follow a common color-coded format. All terminal strip color coding and numbering shall follow a common format. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle, fused on/off power switch, and required transformers shall be provided in each enclosure.

2.04 SENSORS AND INPUT DEVICES

A. Temperature Sensors (Building)

1. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
2. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
3. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
 - a. Point Type Accuracy
 - b. Chilled Water + .5°F.
 - c. Room Temp + .5°F.

- d. Duct Temperature + .5°F.
 - 4. Room sensors shall be constructed for either surface or wallbox mounting.
 - 5. Room sensors shall have the following options when specified:
 - a. Setpoint reset slide switch providing a +3 degree (adjustable) range.
 - b. Individual heating/cooling setpoint slide switches.
 - c. A momentary override request push button for activation of after-hours operation.
 - d. Analog thermometer.
 - e. 1000 ohm thin film nickel sensor
 - f. Acceptable manufacturers: Siemens
- B. Room Pressure Sensors
 - 1. Room sensors shall be constructed for either surface or wall box mounting.
 - 2. Room sensors shall have the following options when specified:
 - a. Display option: LED pressure display.
 - b. Pressure Ranges: Jumper Selectable.
 - c. Mode: Unidirectional or Bidirectional, Jumper-selectable. Output Field Selectable: 2-wire, loop-powered 4-20mA, or 3-wire 05V/0-10V.
 - d. Input power 24VAC/DC nominal.
 - e. Acceptable manufacturers: Veris Industries, model PLX01S
- C. Room Temperature Sensors with Integral Display
 - 1. Room sensors shall be constructed for either surface or wallbox mounting.
 - 2. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - a. Display room and outside air temperatures.
 - b. Display and adjust room comfort setpoint.
 - c. Display and adjust fan operation status.
 - d. Timed override request push button with LED status for activation of after-hours operation.
 - e. Display controller mode.
 - f. Password selectable adjustment of setpoint and override modes.
- D. Thermowells
 - 1. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and Greenfield fitting.
 - 2. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 - 3. Thermowells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
 - 4. Thermowells shall be constructed of brass.
- E. Outside Air Sensors
 - 1. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - 2. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - 3. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

F. Averaging Sensors

1. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification may exist, an averaging sensor with multiple sensing points shall be used.
2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
3. Capillary supports at the sides of the duct shall be provided to support the sensing string.

G. Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 ma output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - e. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - f. Acceptable manufactures: Mamac
2. Low Differential Water Pressure Applications (0" - 20" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 ma output in response to variation of flow meter differential pressure or water pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) .01-20" w.c. input differential pressure range.
 - 2) 4-20 ma output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - c. Acceptable manufactures: Mamac
3. Medium to High Differential Water Pressure Applications (Over 21" w.c.)
 - a. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
 - 1) Differential pressure range 10" w.c. to 300 PSI.
 - 2) Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).
 - 3) Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections

- piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
- b. Acceptable manufactures: Mamac
 - 4. Building Differential Air Pressure Applications (-1" to +1" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 ma output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - c. -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
 - 1) 4-20 ma output.
 - 2) Maintain accuracy up to 20 to 1 ratio turndown.
 - 3) Reference Accuracy: +0.2% of full span.
 - d. Acceptable manufactures: Mamac
 - 5. Low Differential Air Pressure Applications (0" to 5" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 ma output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - 2) 4-20 ma output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - c. Acceptable manufactures: Mamac
 - 6. Medium Differential Air Pressure Applications (5" to 21" w.c.)
 - a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
 - 1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
 - 2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (up to 100 PSIG).
 - 3) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
 - b. Acceptable manufactures: Mamac
 - H. Static Pressure Traverse Probe
 - 1. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
 - 2. Acceptable manufacturers: Cleveland Controls
 - I. Shielded Static Air Probe

1. A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.
 2. Acceptable manufacturers: Cleveland Controls
- J. Power Monitoring Devices
1. Current measurement (Amps) shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 ma DDC compatible signal for use by the Facility Management System.
 2. Current Transformer - A split core current transformer shall be provided to monitor motor amps.
 - a. Operating frequency - 50 - 400 Hz.
 - b. Insulation - 0.6 Kv class 10Kv BIL.
 - c. UL recognized.
 - d. Five-amp secondary.
 - e. Select current ratio as appropriate for application.
 - f. Acceptable manufacturers: Veris Industries
 3. Current Transducer - A current to voltage or current to ma transducer shall be provided. The current transducer shall include:
 - a. 6X input over amp rating for AC inrushes of up to 120 amps.
 - b. Manufactured to UL 1244.
 - c. Accuracy: +. 5%, Ripple +1%.
 - d. Minimum load resistance 30kOhm.
 - e. Input 0-20 Amps.
 - f. Output 4-20 ma.
 - g. Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
 - h. Acceptable manufacturers: Veris Industries
- K. Status and Safety Switches
1. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
 2. Current Sensing Switches
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries
- L. Air Filter Status Switches

1. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
2. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
3. Provide appropriate scale range and differential adjustment for intended service.
4. Acceptable manufacturers: Cleveland Controls

M. Air Flow Switches

1. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
2. Acceptable manufacturers: Cleveland Controls

N. Air Pressure Safety Switches

1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
3. Acceptable manufacturers: Cleveland Controls

O. Water Flow Differential Pressure Switches

1. Water flow switches shall be equal to Siemens.
2. Acceptable manufactures: Siemens or approved equal.

P. Low Temperature Limit Switches

1. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
2. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
3. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
4. Acceptable manufactures: Siemens or approved equal.

2.05 OUTPUT DEVICES

A. Control Relays

1. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
2. Mounting bases shall be snap-mount.
3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
4. Contacts shall be rated for 10 amps at 120VAC.
5. Relays shall have an integral indicator light and check button.

2.06 POWER SUPPLIES AND TRANSFORMERS

A. DC Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

B. Transformers

1. Sized to provide volts and amps as required for connected load.
2. Input voltage shall be as required for the specific application.

2.07 ACTUATORS

A. Damper and valve actuators shall be electronic, as specified in the Sequence of Operation, Control Drawings and Wiring Diagrams.

B. Electronic Damper Actuators

1. Electronic damper actuators shall be direct shaft mount.
2. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction and a gear release to allow manual positioning.
3. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 ma, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
4. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
5. Acceptable manufacturers: Siemens or approved equal.

C. Electronic Valve Actuators

1. Electronic valve actuators shall be manufactured by the valve manufacturer.
2. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
3. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-

off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

4. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 ma and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
5. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
6. Acceptable manufacturers: Siemens or approved equal.

2.08 CONTROL DAMPERS

- A. Performance: Test in accordance with AMCA 500.
- B. All automatic dampers shall be sized for the application or as specifically indicated on the Drawings.
- C. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- D. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- E. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48". Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be provided for any section exceeding 48" in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.5 cfm per square foot when closed against 4" w.c. static pressure when tested in accordance with AMCA Std. 500.
- F. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.c., but no more than 4000 FPM or 6" w.c.
- G. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

- H. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.
- I. Acceptable manufacturers are: Ruskin CD-50, or approved equal.

2.09 HYDRONIC TEMPERATURE SENSORS

- A. General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Dual Water temperatures in a mechanical room environment.
- B. Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. A calibration report for each RTD & Transmitter matched pair must be furnished to the Owner.
- C. RTD:
 - 1. RTD type: 2-wire or 3-wire 100 ohm platinum class A or B.
 - 2. Outside Diameter: 0.25 inch
 - 3. Tolerance: +/- 0.06% Type A, +/- 0.12% Type B.
 - 4. Stability: +/- 0.1 % over one year.
 - 5. TCR: 0.00385 (ohm/ohm/oC).
 - 6. RTD shall be tip sensitive.
 - 7. Resistance vs. Temperature table for the RTD must be provided to the Owner.
- D. Transmitter:
 - 1. Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
 - 2. Type: 2 wire (loop powered).
 - 3. Input: 2 or 3 wire 100 ohm platinum class A or class B RTD.
 - 4. Output: Output shall be a 4-20 mA signal linear to temperature.
 - 5. Calibrated Span:
 - a. Chilled Water: 30°F to 130°F
 - b. Dual/Hot Water: 30°F to 230°F.
 - 6. Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 oF, whichever is greater.
 - 7. Supply Voltage: 24 VDC.
 - 8. Ambient Operating Temp: 32 to 122°F
 - 9. Epoxy potted for moisture resistance.
 - 10. Mounting: Transmitter shall be mounted in the RTD connection head.
- E. Thermowell
 - 1. Thermowell shall be suitable for immersion in Chilled Water.
 - 2. Thermowell shall be stainless steel.
 - 3. Thermowell shall have 1/2" NPT process connection to pipe thred-o-let.
 - 4. Thermowell Insertion depth shall be no more than 2/3 and no less than 1/3 of the inside pipe diameter.
- F. Assembly:

1. Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
 2. Connection head shall be cast aluminum with chain connecting cap to body, have 1/2" NPT process and 3/4" NPT conduit connections, and a sealing gasket between cap and body.
- G. RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
1. Manufacturer: Minco Products, Inc.
 2. Model: AS5004-PD-[assembly length code]-Y-2-A-291-calibrated span code
 3. With Thermowell: TW239U-thermowell insertion length

2.10 CONTROL VALVES

- A. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule.
- B. Heating and chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
- C. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.
- D. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
- E. Acceptable manufacturers: Siemens or approved equal.

2.11 Low voltage cable

- A. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC and General Purpose Cabling.

1. Cable shall consist of copper conductors not less No. 18 AWG-stranded.
 2. Shall be 2 or 3 conductor twisted cable with a drain wire.
 3. Cable shall have a 100% overall shield.
 4. Cable shall be a plenum-rated.
 5. Cable shall meet or exceed NEC voltage rating of 300V.
 6. Cable shall be NEC type CMP.
 7. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 8. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name and the type of signal carried within the cable, i.e. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC.
 9. Each of the cable types specified in Item A shall be of a different color coding for easy identification and troubleshooting. Required color coding:
 - a. Analog Input Cable: Yellow
 - b. Analog Output Cable: Tan
 - c. Binary Input Cable: Orange
 - d. Binary Output Cable: Violet
 - e. 24 VAC Cable: Gray
 - f. General Purpose Cable: Natural
- B. Primary and Secondary Communications Network Cabling.
1. Cable shall be of type recommend by the DDC System Manufacturer.
 2. Cable shall be shielded.
 3. Cable shall be a plenum-rated.
 4. Cable shall meet or exceed NEC voltage rating of 150V.
 5. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 6. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name, system name and the communications network name.
 7. Each of the cable types shall be of a different color-coding for easy identification and troubleshooting and shall be of a different color than the cable specified in Item A above.
- C. Room Sensor Cabling
1. Cable shall consist of copper conductors not less No. 24 AWG.
 2. Shall be multi-paired (at least two pairs) twisted cable.
 3. Cable shall have a 100% overall shield.
 4. Cable shall be a plenum-rated.
 5. Cable shall meet or exceed NEC voltage rating of 300V.
 6. Cable shall be NEC type Article 800-CMP.
 7. Cable shall meet or exceed UL temperature rating of +75 degrees C.
 8. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name and labeled as a stat cable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Completely install automatic temperature control system as specified.
- B. Coordinate installation of devices, wiring, and other items with other trades.

- C. Locate thermostat/sensors where they will not be affected by heat from other sources, such as direct rays of sun, pipes or ducts in wall, convectors, direct air currents from diffusers, light dimmers and similar items.
- D. Coordinate locations of space temperature sensors as indicated or approved by owner representative.
- E. Low temperature protection thermostat shall be located upstream of the cooling coil. The entire duct area shall be covered to detect low air temperature due to stratification.
- F. Current sensing relay trip levels shall be set to indicate the motor running under load vs. no load.
- G. Verify wiring terminations at all devices and correct as required. Provide identification label for each termination.

3.02 START-UP SERVICES

- A. Verify proper location of each device and point-to-point BAS integrity, correct as needed.
- B. When installation is complete and automatic control system is placed in operation, adjust and calibrate all instruments and devices in system and ensure that system is operating in accord with specified sequences.
- C. Diagnose component and system problems. Communicate irregularities to the appropriate contractor for correction.
- D. Attend construction meetings as required to coordinate with other contractors and provide input during problem resolution.

3.03 SENSORS AND INPUT DEVICES

- A. All Input devices shall be installed per the manufacturer's recommendation.
- B. Building Differential Air Pressure Applications: Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind. The interior tip shall be inconspicuous and located within a central corridor shown on the drawings.
- C. Outside Air Humidity Sensors: Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- D. Outside Air Sensors: Outside air sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air temperatures accurately. Sensors exposed to solar radiation must be installed with solar shields. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
- E. Space Temperature Sensors: Shall be mounted 42-50" above the finished floor unless otherwise noted on Mechanical or Architectural Sheets

- F. Low Temperature Limit Switches: Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
- G. Duct Mount Sensors
 - 1. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - 2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - 3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- H. Veris Industry Hawkeye H8026 Series Enhanced Data Stream Electric Power Meter
 - 1. See electrical drawings for device location and installation details

3.04 OUTPUT DEVICES

- A. All output devices shall be installed per the manufacturer recommendation.

3.05 WIRING

- A. Install wiring in accordance with National Electric Code; ANSI/NFPA 70.
- B. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures. For concealed and accessible areas, plenum rated wiring and cabling may be used.
- C. For all pool area conduit and raceway use only aluminum materials or water tight flexible conduit. All conduits in slab to be PVC.
- D. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.
- E. Low voltage control wiring and 24VAC can be run in the same conduit. Power wiring 120VAC and greater must be in a separate conduit.
- F. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors or expansion shields. All-purpose plastic anchors are not acceptable.
- G. Control panels shall be mounted on vibration free walls or freestanding structural supports. Panels shall be located as indicated or approved by owner representative.
- H. Locate circuits, relays, transformers or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.
- I. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size 3/4".

- J. All devices located in pool area to be rated for pool environment. All exposed conduits in pool area to be aluminum or water tight flexible conduit. All recessed or in slab conduit in pool area to be PVC.

3.06 INCIDENTAL CONTROL WIRING

- A. Incidental control wiring includes: boiler control system, chimney automation system and variable frequency drives.

3.07 IDENTIFICATION STANDARDS

- A. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.
- B. Controller Identification: All controllers shall be identified by typed (not handwritten) securely attached tag label.
- C. Panel Identification: All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
- D. Panel Devices: All panel devices shall be identified by a typed label securely fastened to the back plate of the local control panel.
- E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
- F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

3.08 TRAINING

- A. Provide demonstration and training in accordance with Division 01 79 00.

END OF SECTION 23 0920

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SECTION 23 2000 - PIPE JOINING

PART I - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes pipe joining methods for Hydronic, Steam and Condensate Piping
 1. Soldering
 2. Brazing
 3. Threading
 4. Flanges
 5. Welding
 6. Heat Fusion Welding

1.03 RELATED SECTIONS

- A. Section 23 3113 - Hydronic Piping
- B. Section 23 2116 - Hydronic Specialties
- C. Section 23 2213 - Steam and Condensate Piping
- D. Section 23 2216 - Steam and Condensate Specialties

1.04 REFERENCES

- A. ASME Standard B31.1 - Power Piping
- B. ASME Standard B31.9 - Building Services Piping
- C. ASME Standard B31.5 Refrigeration Piping and Heat Transfer Components
- D. ASME Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications
- E. All applicable ASME Standards for welding and brazing
- F. ASTM B32 - Standard Specification for Solder Metal
- G. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
- H. ASTM 828 - Standard for Making Capillary Joints by Soldering Copper and Copper Alloy Tubes and Fittings
- I. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding

- J. AWS B2.1 - Specification for Welding Procedure and Performance Qualification
- K. All applicable AWS D10 Standards
- L. Copper Development Association - Copper Tube Handbook
- M. International Mechanical Code

1.05 QUALITY ASSURANCE

- A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph above entitled REFERENCES.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joints shall be repaired or replaced at no cost to Owner.
- C. Installation shall be in compliance with Manufacturer's recommendations.

1.06 SUBMITTALS

- A. Product Data
 - 1. Solder and flux
 - 2. Brazing filler metal and flux
 - 3. Flange Gaskets: Type, material, construction, temperature/ pressure rating
 - 4. Bolts and Nuts: Type, material, ASTM identification
 - 5. Weld consumables
- B. Documentation
 - 1. Welder qualifications
 - 2. Welding procedures
 - 3. Field records
 - 4. Field test reports

1.07 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. All materials shall be stored indoors protected from temperature, physical damage and exposure to fluids, dust and debris. Containers of solder, brazing and weld consumables, pastes and fluids shall remain sealed until use. Opened containers shall be kept sealed when not in use.

1.08 WARRANTY

- A. All products and installation thereof shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. All joints shall be warranted to be free from leaks and imperfections for same time period. Defective joint shall be repaired or replaced at no cost to Owner. Impacted piping system shall be manipulated as required to make repair and fluid media shall be brought back to original condition and fill volume at no cost to Owner.

PART 2 - PRODUCTS

2.01 DISSALLOWED PIPE JOINING METHODS

- A. Roll groove or cut groove joints
 - 1. For exception see Section 23 3113 - Hydronic Piping
- B. Press-connect joints
 - 1. For exception see Section 23 3113 - Hydronic Piping
- C. Mechanically formed extruded outlets
- D. Piercing valves and fittings
- E. Saddle connections
- F. Welded branch connections
- G. Reducing bushings and flanges
- H. Dielectric unions or fittings
 - 1. For exception see Section 23 3113 - Hydronic Piping
- I. Other non-standard pipe joints

2.02 PIPE AND FITTINGS

- A. Pipe, Fittings, Unions, Flanges
 - 1. See Section 23 2113 - Hydronic Piping for specifications
 - 2. See Section 23 2213 - Steam and Condensate Heating Piping for specifications

2.03 SOLDER JOINTS

- A. Approved Fill Material
 - 1. ASTM B32 alloy E
 - a. 95% tin, 5% copper
 - 2. ASTM B32 alloy HB
 - a. Tin-antimony-copper-zinc-silver

2.04 BRAZED JOINTS

- A. Fill Material
 - 1. Cuprous metal to cuprous metal: 15% minimum silver content
 - 2. Cuprous metal to steel: 45% minimum silver content
 - 3. High temperature, high pressure or lab/process piping applications: 15% minimum silver content
 - 4. Joints difficult to access (e.g. closed chases, underground): 15% minimum silver content

2.05 THREADED JOINTS

- A. Thread Sealant
 - 1. Paste type, non-hardening, rated for temperature.
 - 2. CSM specifications require use of teflon tape in addition to paste.

2.06 FLANGED JOINTS

- A. See Section 23 21 3 - Hydronic Piping for specifications
- B. See Section 23 2213 - Steam and Condensate Heating Piping for specifications

2.07 WELDED JOINTS

- A. Materials and Methods: In compliance with Weld Procedure Specifications (WPS)
- B. Welding Requirements: In compliance with section below entitled WELDING.

PART 3 - EXECUTION

3.01 SOLDERING

- A. Soldering shall be in conformance with Copper Development Association - Copper Tube Handbook including:
 - 1. Selection of solder and flux
 - 2. Measuring and cutting
 - 3. Reaming
 - 4. Application of flux
 - 5. Assembly and support
 - 6. Heating
 - 7. Application of solder
 - 8. Cooling and cleaning
 - 9. Testing
- B. Destructive Testing
 - 1. Note to Contractor: Given destructive testing requirements specified below, adequate quality control is required to avoid potentially substantial and costly rework. Joints will be destructively tested for quality, not just leak-tightness.
 - 2. Destructive testing shall be performed on up to 5% of soldered joints at Contractor's expense. Joints shall be selected by AE or Owner.
 - 3. If any joint is found to be in non-compliance with referenced standards, joint shall be repaired or replaced to satisfaction of AE and up to an additional 10% of joints shall be tested.
 - 4. If additional non-compliant joint or joints are found, all joints identified by AE shall be replaced.

3.02 BRAZING

- A. Brazing shall be in conformance with Copper Development Association - Copper Tube Handbook including:
 - 1. Selection of filler material and flux
 - 2. Measuring, cutting, reaming
 - 3. Application of flux
 - 4. Assembly and support
 - 5. Applying heat and brazing
 - 6. Cooling and removing residue
 - 7. Testing
- B. During brazing, piping shall be purged with oil-free nitrogen.
- C. Joints in following system types shall be brazed:
 - 1. Laboratory and process gas systems
 - 2. Systems with pressures in excess of 350 PSIG
 - 3. Systems with temperatures in excess 450 degrees C
 - 4. Underground copper piping systems
 - 5. Other systems as indicated in project documents
- D. Destructive Testing
 - 1. Destructive testing shall be performed as identified above for solder joints.

3.03 THREADED JOINTS

- A. Tapered NPT threads shall be properly cut on piping at joints.
- B. Joint sealant shall be applied.
- C. Torque shall be applied as required to properly seat threads.

3.04 FLANGED JOINTS

- A. Flanges shall be properly aligned with minimal application of force.
- B. Gasket shall be properly positioned.
- C. Bolts shall be inserted and anti-seize compound applied.
- D. Bolts shall be torqued to specified value.

3.05 WELDING

- A. Qualifications
 - 1. All welders and welding procedure specifications (WPS) shall be qualified as set forth in ASME Boiler and Pressure Vessel Code, Section IX
 - a. Welder
 - 1) Prior to performing project welds documentation shall be submitted confirming that each welder has passed required procedure test. Welders

shall be qualified as required by ASME B31.1 or ASME B31.9 as applicable.

- 2) Welder qualifications shall be current. If qualification test is more than six months old record of continuity shall be provided indicating welder has performed applicable and approved welding at least every six months since date of qualification test. Record of continuity shall be to satisfaction of AE.

b. Weld Procedure Specifications (WPS)

- 1) Welding procedure specifications shall be provided for project specific welding methods and materials.

B. Weld Record

1. For welding within scope of ASME B31.1 procedure for locating, monitoring, recording and maintaining quality of welds shall be submitted to AE for approval.
2. Welder identification shall be provided for each weld. Identification shall consist of pipe stamp and welding record. Requirement for welder identification may be relaxed with written approval of AE.

C. Weld Inspection and Examination

1. All welds in piping and piping components shall be carefully visually examined in accordance with ASME Standard B31.1 or ASME B31.9 as applicable.
2. Periodically, as welding progresses, report shall be provided indicating status of project welding quality.
3. AE and Owner shall be provided opportunity to observe all aspects of welding prior to, during and after fabrication to assure that proper welding is provided to Owner's satisfaction. Off-site shop welding shall be included. Additionally, Owner maintains right to obtain independent weld examination.
4. AE and Owner shall retain right to stop in-progress welding work until resolution of any concerns are resolved to Owner's satisfaction. Such shall be at no cost to Owner.
5. Welds in piping and piping components shall be radiographically examined. 10% of welds shall be examined each month. Radiographic examination shall be in accordance with ASME B31.1. Number or percentage of welds to be examined shall be as indicated in project documents. Specific welds to be examined shall be selected by AE. Testing agency shall be approved by AE and Owner.

D. Welding Procedure

1. All welding shall comply with applicable requirements of referenced ASME and AWA Standards.
2. All fittings shall be factory standard fittings. Fabricated fittings not allowed.
3. Backing rings shall not be used with welded joints.
4. Interior of pipe and fittings shall be thoroughly cleaned prior to and after welding/assembly.
5. Welds shall be built up with stringer-bead pass followed by hot pass, followed by cover or filler pass.
6. Valleys at center or edges of welds not allowed. Unsound or unfused metal, cracks, oxidation, blow holes or non-metallic inclusions not allowed. Any such imperfections shall be corrected in compliance with referenced standards and to satisfaction of AE and Owner.

7. When hot-tapping, slag, drillings or “cookies” shall be prevented from entering piping system to greatest degree possible. Any material that enters piping shall be removed by use of magnet after drilling or cutting is complete.
8. Each weld shall be painted shortly after completion to prevent corrosion. Paint shall be high temp type.

3.06 FUSION WELDING - POLYPROPYLENE

- A. PP-R and PP-RCT polypropylene pipe and fittings shall be fusion welded per Manufacturer’s instructions.
 1. Joints in piping 4” and smaller shall be heat fusion socket welded.
 2. Joints in piping 6” and larger shall be heat fusion butt welded.

END OF SECTION 23 20 00

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SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes pipe, pipe fittings, materials, joining methods and general duty valves for the following:
 - 1. Heating water piping system.
 - 2. Chilled water piping system
 - 3. Condensate drain piping.
 - 4. Air-vent piping.

1.03 Related Requirements

- A. Section 23 0529 - Hangers and Supports for HVAC
- B. Section 23 0548 - Vibration and Seismic Control for HVAC
- C. Section 23 0553 - Identification for HVAC
- D. Section 23 0711 - HVAC Insulation.
- E. Section 23 2114 - Hydronic Specialties.
- F. Section 23 2513 - HVAC Water Treatment for Closed Systems
- G. Section 23 0516 - HVAC Water Treatment for Open Systems
- H. Section 23 8316 - Hydronic Snowmelt Systems

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

- G. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300; 2025.
- H. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- I. ASME B31.9 - Building Services Piping; 2020.
- J. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
- K. ASSE 1079 - Performance Requirements for Dielectric Pipe Unions; 2012.
- L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
- N. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples; 2025.
- O. ASTM B32 - Standard Specification for Solder Metal; 2020.
- P. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- Q. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
- R. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- S. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
- T. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- U. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- V. ASTM F1545 - Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges; 2015.
- W. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.; 2011 and errata.
- X. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020.
- Y. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 200.
- Z. IAPMO PS 66 - Dielectric Fittings; 2015.
- AA. MSS SP-67 - Butterfly Valves; 2017, with Errata.
- BB. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

CC. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

DD. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.

1.05 SUBMITTALS

- A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
- C. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- D. Qualification Data: For Installer.
- E. Welding Certificates: Include welders certification of compliance with ASME BPVC-IX .
- F. Field quality-control reports.

1.06 REGULATORY REQUIREMENTS

- A. Conform ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.07 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating shall be clearly marked on the outside of the valve body.
- B. Welding Materials and Procedures: Conform to Chapter V, ASME B31.9 and applicable state labor regulations.
- C. Welders Certification: Furnish in accordance with AWS D1.1/D1.1M and ASME B31.9.
- D. Each threaded fitting shall be stamped as specified by ASME B16.3.

- E. Each welded fitting shall be stamped as specified by ASME BPVC-IX ASME B31.9.
- F. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- G. Pipe Welding: Qualify procedures and operators according to ASME BPVC-IX.
 - 1. Comply with ASME B31.9 for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.08 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Use non-conducting dielectric connections whenever jointing dissimilar metals.
- D. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- E. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Use globe valves for throttling, bypass, or manual flow control services.
- G. Use butterfly valves in heating water systems interchangeably with gate and globe valves.
- H. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.

- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated
- B. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- C. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Provide pipe hangers and supports in accordance with ASME B31.9, specification 200529, and specification 230529 unless indicated otherwise.
- D. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- E. Valves: Provide valves where indicated and as follows:
 - 1. On supply and return of all equipment.
 - 2. At each main serving a floor.
 - 3. At each branch from the main piping rack in garage levels.
 - 4. At the base of every riser.
 - 5. Provide drain valves where indicated on plans. In addition to locations shown on plans, provide drain valves at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 - 6. Isolate equipment using butterfly valves with lug end flanges.

2.03 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B88 (ASTM B88M), Type L (B) or Type M (C) ASTM B88 (ASTM B88M), hard drawn using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
 - 2. Tee Connections: All tees to be wrought copper fittings with solder joints. Pulled Tee's are not allowed. Mechanically Formed Tee Option by Manufacturers such as T-Drill Industries for forming T-branch on copper water tube is not acceptable
 - 3. Copper and Bronze Pressure-Seal Fittings, better known as Pro-Press: NOT PERMITTED.
- B. Annealed-Temper Copper Tubing: ASTM B88, Type K.

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
 2. Tee Connections: All tees to be wrought copper fittings with solder joints. Pulled Tee's are not allowed. Mechanically Formed Tee Option by Manufacturers such as T-Drill Industries for forming T-branch on copper water tube is not acceptable
- C. DWV Copper Tubing: ASTM B306 , Type DWV.
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
 2. Tee Connections: All tees to be wrought copper fittings with solder joints. Pulled Tee's are not allowed. Mechanically Formed Tee Option by Manufacturers such as T-Drill Industries for forming T-branch on copper water tube is not acceptable
- D. Wrought-Copper Unions: ASME B16.22.

2.04 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53, black steel with plain ends; welded and seamless, Grade B, and Schedule 40.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- D. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.
- E. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- F. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.05 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

- b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.06 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2-1/2 Inches and Under:
 - 1. Copper Pipe: Bronze, soldered joints, ASME B16.22.
- B. Flanges for Pipe Over 2-1/2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
- C. Dielectric Connections: Union or waterway fitting with water impervious isolation barrier and one galvanized or plated steel end and one copper tube end, end types to match pipe joint types used.

2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions: Permitted at equipment connections only and on the equipment side of the service isolation valves for the equipment. Dielectric unions not permitted on pipeline size transitions between steel and copper.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Watts Regulator Co.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company

- c. Watts Regulator Co.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 - D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
 - E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnel Mechanical Products.
 - b. Precision Plumbing Products.
 - c. Victaulic Company.
 - 2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.
- 2.08 SYSTEM VALVES
- A. Specification for above ground heating piping also applies to the following:
 - 1. Runaround loop piping.
 - B. Blowdown Valves: Shall be provided for all strainers.
 - C. Shut-Off Valves With Gate Drain Valves: Shall be provided in branches and risers.
 - D. Lock-Shield Balancing Valves: Shall be provided at all heating units and in return risers and return mains.
 - E. Manual Vents: Shall be provided on all convectors and radiators.
 - F. Isolation Service: Ball valves (2 inches IPS and smaller) and butterfly valves (2.5 inches IPS and larger) may be used for isolation service in hydronic systems. All ball valves in closed loop

hydronic systems shall be full port design to minimize pressure drop. In hot water systems, ball valves shall have components rated for applicable temperatures.

- G. Globe Valves 3 Inches Diameter and Larger: Class 125 # SWP, 200 # WOG, bolted bonnet, body and bonnet shall be of ASTM A126 Class B cast iron, flanged ends, bronze trim, non-asbestos packing, MSS SP-85.
- H. Globe Valves 2.5 Inches Diameter and Smaller: Class 150 # SWP, 300 # WOG, union bonnet, body and bonnet shall be of ASTM B62, TFE disc, integral seat, malleable iron handwheel, non-asbestos packing, MSS SP-85.
- I. Check Valves 3 Inches Diameter and Larger: Class 125 # SWP, 200 # WOG, horizontal swing check, body and cap shall be of ASTM A126 cast iron, bronze trim, bolted cap, flanged ends, including adjustable spring, lever, and weights oriented per application (horizontal or vertical piping), MSS SP-71.
- J. Check Valves 2.5 Inches Diameter and Smaller: Class 150 # SWP, 300 # WOG, horizontal swing check, body and cap shall be of ASTM B62 cast bronze, TFE disc, integral bronze seats, MSS SP-80.
- K. Ball Valves 3 Inches Diameter and Smaller: 600 # WOG, 150 # SWP, 2 piece body style, full port, CP brass tunneled ball, reinforced teflon seats, hex gland follower, bronze body of ASTM B584, blow-out proof stem, lever handle.
- L. Butterfly Valves 2.5 Inches Diameter and Larger: 200 # WOG, ductile iron full lug body, bronze or stainless steel disc, 316 SS stem, field-replaceable phenolic-backed EPDM cartridge style seat ("boot" type seats without backing rings are not acceptable), blow-out proof stem, MSS SP-67. Valves shall be bi-directional bubble tight shut off rated for in-line service as well as dead end service with either mating flange removed. Valves 6" and smaller shall be provided with a 10 position lever handle, 8" and larger with a geared rotary hand wheel operator.
- M. Silent Globe Style Check Valves 2.5 Inches Diameter and Larger: 200 # WOG minimum, body shall be of ASTM A126 Class B cast iron, center guided, stainless steel spring and screws, bronze disc, bronze seat.
- N. Valves which are insulated shall have stem extensions and plastic insert/cap to keep insulation clear of the stem.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS (add piping class, groove fittings, propress, fitting types)

- A. Where more than one piping type is specified, selection shall be Contractor's option.
- B. Hot-water heating piping, NPS 2-1/2 and smaller shall be the following:
 - 1. Type L drawn-temper copper tubing, wrought-copper fittings, and with soldered joints.
 - 2. Standard weight (schedule 40), Grade B, Type 96 steel pipe; malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 - a. Fitting Class: Class 150
- C. Hot-water heating piping, aboveground, NPS 3" and larger shall be the following:

1. Standard Weight steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 2. Mechanical grooved coupling systems not permitted on heating water piping systems.
- D. Chilled-water piping aboveground, NPS 2-1/2" and smaller shall be of the following:
1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered or joints.
- E. Chilled-water piping, aboveground, NPS 3" and larger, shall be the following:
1. Standard weight (schedule 40) steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- F. Free cooler piping: Refer to specifications for Chilled-water piping.
- G. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 2. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.

3.02 INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Pipe Installation:
1. All the various piping systems shall be made up straight and true and run in orderly manner, plumb and parallel to building structural. Install piping to conserve building space. Coordinate location with other trades and do not interfere with use of space for other work.
 2. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the Site.
 3. Should any unforeseen conditions arise, lines shall be changed or rerouted after proper approval has been obtained.
 4. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, or in equipment to which the lines are connected.
 5. Group piping whenever practical at common elevations.
 6. Slope piping and arrange system to drain at low points. Use eccentric reducers where applicable to maintain the bottom of pipe level.
 7. Branch tap connections are to be from the top to horizontal position of pipe run.
 8. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
 9. Provide and install Pete's plugs adjacent to thermo wells for electronic temperature sensors, to electronic pressure sensors and install Pete's plugs adjacent where shown or noted on piping drawings or drawing details.
 10. Provide clearance for installation of insulation, and access to valves and fittings.
 11. Prepare pipe, fittings, supports, and accessories for finish painting. Chilled water piping insulated with cellular glass does not require finish painting.

12. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.
 13. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.
 14. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon tape or Teflon-based compound appropriate to the medium, material and temperature range of the system. Compound shall be applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.
- C. Valve Installation:
1. Locate all valves such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so the valve stem is inclined one bolt hole above the horizontal position.
 2. Screw pattern valves placed in horizontal lines shall be installed with their valve stems include at an angle of a minimum of 30 degrees above the horizontal position.
 3. All valves must be true and straight at the time the system is tested and inspected for final acceptance.
 4. Valves shall be installed as nearly as possible to the locations indicated in the Drawings. Any change in valve location must be so indicated on the Record As-Built Drawings.
 5. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this Project.
 6. Equipment, valves, expansion joints, relief devices, strainers, etc., must be removed or isolated during the test if the pressure/force ratings of the devices are not as high as that specified for the test. Piping shall be drained and protected any time ambient temperature is below freezing.
 7. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.
 8. All threaded valves installed in copper piping shall be provided with copper or bronze male adapters on each side of valves. Sweat solder adapters to pipe before installing valves.
 9. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with architectural drawings.
 10. Install valves with stems upright or horizontal, not inverted.
 11. All manually operated shutoff valves 3" and larger located 8 feet (Bottom of pipe) or higher above finished floor or stationary platform in mechanical rooms, accessible pipe chases or as noted on Project Drawings shall be chain wheel operated. Chains shall be installed and secured to allow clear passage at walk through areas.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install manual air vent with isolation valve at all ends and high points in system that could otherwise air bind.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install piping to allow application of insulation.
- M. Select system components with pressure rating equal to or greater than system operating pressure.
- N. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- O. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- P. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- Q. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- R. Install branch connections to mains using mechanically formed fittings (pulled-tees are not acceptable) in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- S. Bullhead tees shall not be utilized on piping systems.
- T. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- U. Install flanges in piping, NPS 2-1/2 and larger, at all valve assemblies and final connections of equipment and elsewhere as indicated.
- V. Install shutoff valve immediately upstream of each dielectric fitting.
- W. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- X. Comply with requirements in Section 230553 "Identification for HVAC" for identifying piping.
- Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC."
- Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC."
- AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 0518 "Escutcheons for HVAC Piping."

3.03 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions. Dielectric Unions permitted only at equipment connections on the equipment side of service isolation valves. At copper pipe size branch connections to steel pipe size mains and material size transition fittings not protected by service isolation, use dielectric nipple only.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 23 0548 "Vibration Controls for HVAC" for seismic restraints.

3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Mechanically Formed, Copper-Tube-Outlet Joints: Not Permitted.

3.06 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 0519 "Meters and Gages for HVAC Piping."

3.07 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

3.08 TESTING

- A. All welds are subject to inspection, visual and/or x-ray, for compliance with Specifications. The Owner will, at the Owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or x-ray testing. Initial visual and x-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME B31.9 due to the discovery of poor, unacceptable or rejected welds.
- B. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.
- C. System Pressure Tests: All Hydronic Systems shall be tested at 1.5 time the operating pressure. Minimum 125 psi. The test shall be done with water.
- D. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- E. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, and fluid coolers to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 23 2113

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SECTION 23 2116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Air vents.
 - 2. Air/dirt separators.
 - 3. Pressure relief valves
 - 4. Strainers.
 - 5. Balancing valves
 - 6. Coil package sets.
 - 7. Expansion tanks
 - 8. Connectors
- B. Related Requirements:
 - 1. Division 23 Section - Hydronic Piping.
 - 2. Division 23 Sections for HVAC Water Treatment.

1.03 REFERENCE STANDARDS

- A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2007.

1.04 SUBMITTALS

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- C. Project Record Documents: Record actual locations of flow controls.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 MAINTENANCE SERVICE

- A. Furnish service and maintenance of glycol system for one year from date of substantial completion.
- B. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com.
 - 2. Armstrong International, Inc: www.armstronginternational.com.
 - 3. ITT Bell & Gossett: www.bellgossett.com.
 - 4. Taco, Inc: www.taco-hvac.com.
- B. Float Type:

1. 125 psig pressure rating, brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Locate all air vents and their discharge lines in accessible locations, preferably clustered
3. Route discharge lines to nearest floor drain without air traps.

2.03 Coalescing-Type Air and Dirt Separators:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Armstrong Pumps, Inc.
 2. Bell & Gossett; a Xylem brand.
 3. Spirotherm, Inc.
 4. **Amtrol**
- B. Tank: Fabricated steel tank; ASME constructed and stamped for 125-psig (862-kPa) working pressure and 270 deg F (130 deg C) maximum operating temperature.
- C. Not all manufacturers offer the coalescing mediums listed below. Coordinate with retained manufacturers.
- D. Coalescing Medium: Stainless steel.
- E. Air Vent: Threaded to the top of the separator.
- F. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 (DN 65) and larger.
- G. Blowdown Connection: Threaded to the bottom of the separator.
- H. Size: Match system flow capacity.

2.04 STRAINERS

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com.
 2. WEAMCO: www.weamco.com.
- B. Size 2 inch and Under:
 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen. Lifting lugs for lid
- E. Coordinate with Hydronic Pumps for requirements

2.05 HYDRONIC BALANCING VALVES

- A. Description: Multi-Turn Globe Style Valve: Each valve shall be a multi-turn globe style valve capable of bubble-tight shut-off with a memory device and indicator scale
- B. Manufacturers: Provide products by one of the following.
 - 1. Tour & Anderson
 - 2. Armstrong International, Inc.
 - 3. Wheatley
 - 4. Nexus
 - 5. Patterson Pump Company
- C. Scope: Scope includes valves used for general balancing and isolation service, 1.5 to 6 inch, up to 125 psig maximum.
- D. Return Piping Installation: Balancing valves shall be installed in the return piping, NOT in supply piping. Provide adequate straight pipe upstream and downstream of balancing valves as required by the manufacturer.
- E. Flow Measurement Ports: Each valve shall incorporate flow measurement ports to allow balancing. Ports shall be within 45 degrees of valve stem to facilitate access to handle and ports.
- F. Infinite Setting Devices: Each valve shall incorporate infinite setting devices to prevent reopening past established balancing position when valve is used for isolation purposes.
- G. Sizing: Each balance valve shall be sized for the specified flow rate (gpm) of the associated equipment. Balance valves shall not be simply specified as "line size".

2.06 COIL PACKAGE VALVE SET - HOT WATER TERMINAL COILS

- A. Install per manufacturers recommendations and instructions on hot water terminal coils with automatic flow control Valves from ½ inch thru 2 inch: valve bodies shall be manufactured from brass ASTM B 283 capable of working at a maximum temperature of 370 F. at a pressure of 600 psi. The valve body is a Y type with cartridge set capable of working and maintaining flow rate at a differential pressure range between 2 to 45 psi.
- B. Valves shall be furnished with precision machined cartridge orifice to provide automatic flow balancing. The valve shall have a blow down valve to clear fine particulate from the cartridge, and two, 1/4" threaded brass ports located on the inlet side of the valve use to acquire a differential pressure measurement. The ports shall have caps with O-ring seals.
- C. In lieu of automatic flow control valves, Tour and Anderson STAP differential pressure controllers may be installed in conjunction with preset standard TA valves and coil components. Supply side coil package shall including a ball valve Y strainer combo with PT port, union, and blow down. Return side coil package shall include a union port fitting with PT port, manual air vent, union, and male threaded tail piece as well as the TA balancing valve. STAP shall be installed per manufacturer's recommendations and at the locations shown on drawings with a partner TA valve adjacent on the supply line for capillary connection.

2.07 CONNECTORS

- A. Stainless-Steel Bellow, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 2. End Connections: Threaded or flanged to match equipment connected.
 - 3. Performance: Capable of 3/4-inch (20-mm) misalignment.
 - 4. CWP Rating: 150 psig (1035 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.08 Diaphragm-Operated Safety Valves: ASME labeled.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMTROL, Inc.
 - 2. Apollo Valves; Conbraco Industries, Inc.
 - 3. Armstrong Pumps, Inc.
 - 4. Bell & Gossett; a Xylem brand.
 - 5. Spence Engineering Company, Inc.
 - 6. Watts; a Watts Water Technologies company.
 - 7. [Insert manufacturer's name].
- B. Body: Bronze or brass.
- C. Disc: Glass and carbon-filled PTFE.
- D. Seat: Brass.
- E. Stem Seals: EPDM O-rings.
- F. Diaphragm: EPT.
- G. Wetted, Internal Work Parts: Brass and rubber.
- H. Inlet Strainer: removable without system shutdown.
- I. Valve Seat and Stem: Noncorrosive.
- J. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.09 Bladder-Type Expansion Tanks:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMTROL, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Bell & Gossett; a Xylem brand.
 - 4. Flo Fab Inc.
 - 5. TACO Comfort Solutions, Inc.

- B. Tank: Welded steel, ASME rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
- D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. Size per system volume and working temperature

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at all system high points relative to significant branch piping and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.
- E. Provide air separator on suction side of system circulation pump.
- F. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- G. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- H. Pipe relief valve outlet to nearest floor drain.
- I. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger. Coordinate with Hydronic Pumps Specifications
- J. All strainers 4-inch and under to have 1/2-inch ball valve and hose bib adapter at drain. All strainers 5-inch and larger to have 3/4-inch ball valve and hose bib adapter at drain.
- K. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- L. All hydronic system balancing valves to be sized based on flow, per manufacturer's guidelines, not pipe size.

3.02

END OF SECTION 23 21146

SECTION 23 2123 - HYDRONIC PUMPS

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SECTION 23 2213 - STEAM AND CONDENSATE PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This section specifies materials and procedures for the construction of a Steam and Condensate Piping for tunnels, utility plants and buildings; complete and ready for operation.
 - 1. Low, Medium and High Pressure Steam Piping and Fittings
 - 2. Steam Condensate Piping and Fittings
 - 3. Pre-insulated Pipe for Non-buried Application
 - 4. Pipe Fittings.
 - 5. Special Fittings.
 - 6. Pipe installation.
- B. Related Sections:
 - 1. Section 23 2000 - Pipe Joining
 - 2. Section 22 3500 - Domestic Water Heat Exchangers
 - 3. Section 23 2214 - Steam and Condensate Heating Specialties

1.03 QUALITY ASSURANCE

- A. Welders employed by the Contractor shall have passed a qualification test in accordance with the current edition of ANSI B31.1 Section IX, ASME Boiler and pressure vessel code. Welders shall be certified for the type of pipe material specified and position of welds required during fabrication of the piping. Submit the welding certificates and pictorial identification of each welder to the Engineer for review prior to commencing piping fabrication.
- B. All welds shall be identified by the welder's mark and a sequence number. The Contractor shall employ a Certified Welding Inspector (CWI), certified as Level 2 minimum in the NDE methods utilized, independent of the contractor fabricating or installing the piping, to visually examine all welds in accordance with inspection and examination requirements of ANSI B 31.1. Any welds failing the visual inspection shall be ground out, re-welded and radiographed at the expense of the Contractor. The CWI shall submit a written report of his examination of each weld to the Engineer.
- C. Refer to Section 23 2000 - Pipe Joining for additional requirements.

1.04 REFERENCE STANDARDS

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; Latest Addition

- B. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; Latest Addition (ANSI/ASME B31.1).
- C. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; Latest Addition (ANSI/ASME B31.9).

1.05 SYSTEM DESCRIPTION

- A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
- C. Provide pipe hangers and supports in accordance with ASME B31.1 unless indicated otherwise.
- D. Use gate or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use globe valves for throttling, bypass, or manual flow control services.

1.06 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
- D. Project Record Documents: Record actual locations of valves.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 and ASME B31.1 code for installation of piping system.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.

- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 MEDIUM AND HIGH PRESSURE STEAM PIPING (150 PSIG MAXIMUM)

- A. Pipe Sizes: 2 inches and under
 - 1. Pipe: ASTM A53 or ASTM A106, Grade B Seamless, Standard Weight. All nipples shall be Extra Heavy Weight.
 - 2. Joints: 3000 lb Socket Welded or 300 lb malleable iron threaded.
 - 3. Fittings: 3000 lb (WOG), forged steel, ANSI/ASME B16.11 or 300 lb malleable iron
 - 4. Unions: 3000 lb., forged steel (WOG) black or 300 lb malleable iron.
- B. Pipe Sizes 2 1/2 inches and over
 - 1. Pipe: ASTM A53 or ASTM A106, Grade B Seamless, Standard Weight. All nipples shall be Extra Heavy Weight.
 - 2. Joints: Butt Welded
 - 3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234/A234M Grade WPB, ANSI/ASME B16.9
 - 4. Flanges: Class 300. Refer to Union and Flanges Section

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

- A. Pipe Sizes: 2 inches and under
 - 1. Pipe: ASTM A53 Grade B Seamless, Standard Weight
 - 2. Joints: Threaded
 - 3. Fittings: Cast iron screwed fittings, ANSI B16.4 175 WOG.
 - 4. Unions Malleable Iron ground joint with brass seat, 500 lb WOG
- B. Pipe Sizes 2 1/2 inches and over
 - 1. Pipe: ASTM A53 Grade B Seamless, Standard Weight
 - 2. Joints: Butt Welded
 - 3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234/A234M Grade WPB, ANSI/ASME B16.9

2.03 STEAM CONDENSATE PIPING

- A. Pipe Sizes: 2 inches and under
 - 1. Pipe: ASTM A106 Grade B Seamless, Extra Heavy Weight
 - 2. Joints: 3000 lb Socket Welded or 300 lb malleable iron threaded.
 - 3. Fittings: 3000 lb (WOG), forged steel, ANSI/ASME B16.11
 - 4. Unions: 3000 lb, forged steel (WOG) black.
- B. Pipe Sizes: 2 1/2 inches and over
 - 1. Pipe: ASTM A106 Grade B Seamless, Extra Heavy Weight

2. Joints: Butt Welded and Flanged
3. Fittings: Extra Strong, seamless steel, butt weld type, ASTM A234/A234M Grade WPB ANSI/ASME B16.9
4. Flanges: Class 300. Refer to Union and Flanges Section

2.04 CONDENSATE TRAP ASSEMBLY PIPING

- A. Design Pressure 150 psig
- B. Design Temperature: 366°F
- C. Pipe Sizes: 2 inches and under
 1. Pipe: ASTM A106 Grade B Seamless, Extra Heavy Weight
 2. Joints: Screwed
 3. Fittings: Class 300 Malleable Iron
 4. Unions: Class 300 Malleable Iron

2.05 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.9 and ASME B31.1
- B. Refer to section 23 0529.
- C. Refer to Structural Details and Specification

2.06 FLANGES

- A. Flanges
 1. 2-1/2" and Larger: ANSI A105, ANSI B16.5, Hot forged steel weld neck pattern. Slip-on pattern are not allowed unless pre-approved for each individual instance and inspected. Bore dimensions of weld neck flange shall match inside diameter of connected pipe.
 2. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full-face gasket.
 3. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match class of device connected to such as valve and piping specialties.
- B. Flange Gaskets:
 1. Service Temperature (250 F thru 800 F) - Flexitalic style CG, flexible graphite filler, 1/16" thick, 304 SS winding, carbon steel centering ring 0.175" thickness.
- C. Bolting:
 1. Bolts shall be Grade 8 or stronger.
 2. Nuts shall be A-194
 3. Bolts, bolt stud, nuts and washers shall have zinc plated finish. High temperature anti-seize shall be used on all threads.
 4. Thread shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.

- D. Thread rods are not allowed as fastening elements.

2.07 STEAM AND CONDENSATE VALVES

- A. Steam Shutoff 2-1/2" and larger:
 - 1. High performance butterfly valve with flang style body. Quarter turn valve.
 - 2. Body: Cast Steel
 - 3. Seat: RTFE
 - 4. Disc: Stainless Steel
 - 5. Class 300, rated for 400 degrees F
 - 6. Multi-turn geared operator with linkage kit for steam service
 - 7. Manufacturer: Venessa QTF, Class 300 with stainless steel trim
- B. Condensate Shutoff 2-1/2" and larger:
 - 1. High performance butterfly valve with lug style body. Quarter turn valve.
 - 2. Body: Cast Steel
 - 3. Seat: RTFE
 - 4. Disc: Stainless Steel
 - 5. Class 300, rated for 400 degrees F
 - 6. Multi-turn geared operator with linkage kit for steam service
 - 7. Manufacturer: Keystone K-Lok, Class 150 with stainless steel trim
- C. Steam and Condensate Shutoff 2" and smaller:
 - 1. Quarter turn Ball valve with adjustable packing gland, blow-out proof stem design, multifill seats and stuffing box ring..
 - 2. Body: Bronze
 - 3. Seat and packing: Multifill PTFE
 - 4. Ball and stem: 316 Stainless Steel
 - 5. Class 250, rated for saturated steam service to 250 psig.
 - 6. Screwed ends.
 - 7. To be furnished with Apollo 2-1/4" extension handles.
 - 8. Manufacturer: Apollo 70-140 - 64 no equal
- D. Steam and Condensate Throttling 2-1/2" and smaller
 - 1. ANSI B16.34 Forged Steel Class 300 lb globe valve, socket
 - 2. Bolted Bonnet
 - 3. Full Port

2.08 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Stockham
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
 - 1. Bronze or iron body, bronze trim, bronze rotating swing disc with composition seat, threaded ends rate for steam service
- C. Over 2 Inches:

1. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends rated for steam service.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Section 22 3500 - Domestic Water Heat Exchangers and Paragraph 3.05 in this section.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Sleeve pipe passing through partitions, walls, and floors.
- E. Provide clearance for installation of insulation and access to valves and fittings.
- F. Provide access where valves and fittings are not exposed.
- G. Slope steam piping one inch in 40 feet (0.25 percent) in direction of flow. In certain locations, steam flow is counter to pipe slope based on existing tunnel grades. Use eccentric reducers to maintain bottom of pipe level. Install piping without low points or 'bellies'.
- H. Slope steam condensate piping one inch in 40 feet (0.25 percent). Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
- I. Install valves with stems upright or horizontal, not inverted.
- J. For steam valves, 3-inch and larger provide 1-inch warmup bypass with globe valve. Provide 3/4 inch blowdown ball valve with plugged end on each side of valve.
- K. Trap assembly piping to be extra heavy with screwed fittings, cast iron 175 WOG.
- L. All steam system equipment isolation valves 2 1/2" and larger and 8ft. or more above finished floor to require a chain operator that extends to 6 ft. or less above finished floor.
- M. "Weldolets" with outsize 2-1/2" and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used on brance takeoff up to one half (1/2) diameter of main. Use

“Threadolets” where fittings are specified and used “Socketolets” where socket weld fittings are specified. Material of “Weldolets” and “Threadolets” shall match material of piping.

- N. Provide anchors , expansion joints, swing joints, and expansion loops so that piping may expand and contract without damage to itself, equipment or building.

3.03 WELDING

- A. Refer to Section 23 2000 - Pipe Joining

3.04 PREOPERATIONAL CLEANING

- A. Traps and Strainers
 1. All strainer screens in steam and condensate systems shall be temporarily removed.
 2. All steam traps shall be temporarily disconnected from steam and condensate supply piping.
- B. Hand Cleaning
 1. Slag, burrs, solder, thread sealant, etc. shall be physically removed from interior of installed piping system to degree practical as determined by Owner and Engineer.
- C. Steam Supply Piping
 1. Manual and automatic control valves shall be moved to open or closed position as appropriate for flushing.
 2. Instruments and components vulnerable to damage/fouling shall be protected from contamination by temporarily removing, “valving off”, disconnecting from piping, installing bypass piping, installing temporary “pancakes” at flanged connections or other method approved by Owner and Engineer.
 3. All steam supply piping including drip legs and low points shall be filled with clean water and continuously flushed to sanitary drain until effluent is clean to satisfaction of Owner and Engineer.
 4. All steam supply piping shall be energized with live steam after any required reassembly has been accomplished. Supply piping shall be allowed to “cook” for 12 hours minimum while contaminated condensate is safely captured, cooled and conveyed to drain. Process shall include drip legs and other low points in system. Procedure shall be continued until clean condensate is achieved to satisfaction of Owner and Engineer. Minimum “cook” time may be reduced by Owner and Engineer if deemed appropriate.
 5. Samples of clean fluid shall be drawn by Owner for analysis. Samples shall be drawn from Owner selected sites. 72 hour advance notification shall be provided.

3.05 TESTING

- A. All welds are subject to inspection, visual and/or x-ray, for compliance. The Owner requires the first three welds of each individual welder's work to be x-rayed, at the Contractor's expense. Employ a testing laboratory for the purposes of performing said inspections and/or x-ray testing. Coordinate to all initial visual and x-ray inspections to be observed by the Owner and Engineer. The Contractor shall be responsible for all labor, material and travel expenses involved in the initial inspection and any re-inspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional

testing required or recommended by ASME/ANSI Standards B31.1 due to the discovery of poor, unacceptable or rejected welds.

- B. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.
- C. Refer to 22 3500 - Domestic Water Heat Exchangers for hydrostatic testing of piping

3.06 PIPE AND HANGER SUPPORT

- A. See section 23 0529

END OF SECTION

SECTION 23 2214 - STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes:
 - 1. Steam traps.
 - 2. Strainers
 - 3. Dirt Pockets

1.03 RELATED SECTIONS

- A. Section 23 2213 - Steam and Condensate Piping
- B. Section 23 05 00 - Common Work Results for HVAC
- C. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Pump motors.
- D. Section 23 07 16 - HVAC Equipment Insulation.
- E. Section 23 07 19 - HVAC Piping Insulation.
- F. Section 23 22 13 - Steam and Condensate Heating Piping.

1.04 REFERENCE STANDARDS

- A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2007.
- B. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2004 (ANSI/ASME B31.9).
- C. ASTM A 126 - Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings; 2004.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2003.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

- B. Product Data:
 - 1. Provide for manufactured products and assemblies required for this project.
 - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Include electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Colorado standard for installation of boilers and pressure vessels.
- B. Perform Work in accordance with ASME B31.1 standard for installation of piping.
- C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.
- D. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 STEAM TRAPS

- A. Manufacturers:
 - 1. Watson McDaniel
- B. Thermodynamic Steam Trap
 - 1. The steam trap shall be a thermodynamic style in a chrome-moly alloy steel body with an integral strainer and optional blowdown valve. Unit shall have an all stainless steel in-line removable seat and disc capsule assembly. Trap shall be capable of installation in any orientation and self-draining when mounted vertically.
 - 2. Manufacturer: Watson McDaniel TD700S, no equal.

2.02 DIRT POCKETS

- A. Where shown on the drawings, install a dirt pocket with a valved drain at bottom, constructed of pipe fittings, not less than 3" for connections 3" and larger and of the full diameter of the connection served; where smaller than 3", the dirt pockets shall be not less than 6" deep. All dirt pockets to be extra heavy.

2.03 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com
 - 2. Keckley: www.keckley.com
 - 3. Spirax-Sarco: www.spiraxsarco.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements
- B. Medium Pressure Steam (150 psig Maximum)
 - 1. Size 2 inch and Under: Screwed iron body, Class 250, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. Size 2-1/2 through 4 inch: Flanged iron body, Class 250, Y pattern with 3/64 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Strainers shall be integral to and located upstream of all steam traps
- C. Blow down lines shall be directed downward, away from center of tunnel, to prevent damage to utilities below and operating personnel.
- D. Steam Traps:
 - 1. Provide minimum 3/4 inch size on steam mains and branches.
 - 2. Install with union or flanged connections at both ends.
 - 3. All shut off valves on steam traps to be ball valves as specified in 23 22 13.
 - 4. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.
- E. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

END OF SECTION

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SECTION 23 2513 - WATER TREATMENT FOR CLOSED LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. Products specified in this section include the following:
 - 1. Chemical Inhibitors for Water
 - 2. Chemicals for Inhibitors and cleaning
 - 3. Shot Feeder
 - 4. Corrosion Coupon Rack
 - 5. Glycol Feed System
 - 6. Propylene Glycol
- B. Provide a Chemical Services Provider (CSP) to perform the services described below.
- C. Provide water treatment products and services including:
 - 1. Chemicals for cleaning, passivation, and treatment of each system.
 - 2. On-going treatment, chemicals, testing, certification, and reports to demonstrate effective water treatment is maintained at all times.
 - 3. Start-up and operation of chemical treatment equipment.
- D. Provide a complete chemical water treatment program during construction for all new and reused piping networks. This program shall begin from the point each system is filled during construction and extend until Substantial Completion or final Owner acceptance of each system, whichever occurs later. The program shall include water analysis, chemicals, testing, equipment, consulting and service for the following systems:
 - 1. Heating Hot Water System
 - 2. Chilled Water System
 - 3. Glycol contained in each of the above systems
- E. Attend project meetings as required to plan, schedule and coordinate above activities with other project contractors and the Owner.
- F. Provide recommended testing procedures and chemical treatment schedule for Owner's personnel. This information shall be submitted to the owner in a Program Administration Manual.
- G. Related Sections:
 - 1. Section 23 0591 - HVAC System Startup
 - 2. Section 23 0800 - Commissioning of HVAC

3. Section 23 0920 - Control Systems
4. Section 23 2113 - Hydronic Piping
5. Section 23 2116 - Hydronic Piping Specialties

1.03 SUBMITTALS

- A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and complete data on furnished products listed below:
 1. Shot Feeders
 2. Coupon Racks
 3. Glycol Feed System
 4. Flow Indicators
 5. Valves
 6. Product specifications and MSDS's for each chemical used
 7. Cleaning Procedures
 8. Passivation Procedures
 9. Chemical Treatment Procedures
 10. Shop Drawings
- B. Shop Drawings to include detailed equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and the location and size of each field connection as necessary to assist the mechanical contractor with proper system installations
- C. Submit resume of water treatment personnel and name of Chemical Services Provider.
- D. Service Reports as indicated under Part 2 below.

1.04 QUALITY ASSURANCE

- A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.
- B. Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.
 1. American Society for Testing and Materials (ASTM)
 - a. D859 - Test Method for Silica in Water
 - b. D1067 - Test Methods for Acidity/Alkalinity in Water
 - c. D1068 - Test Methods for Iron in Water
 - d. D1126 - Test Method for Hardness in Water
 - e. D3370 - Practices for Sampling Water from Closed Conduits
 - f. D4012 - Test Method for Adenosine Triphosphate (ATP) Content of Microorganisms in Water
 - g. D5465 - Practice for Determining Microbial Colony Counts from Waters Analyzed by Plating Methods
- C. Conform to all applicable Codes, Regulations, and Municipal requirements for the use and disposal of chemicals (including cleaning compounds) and waste to public sewer systems.

1. Wastewater shall be discharged to the sanitary sewer only if it has a pH between 5.0 and 10.0 and meets the requirements of the City of Evanston, WY sewer use criteria.
 2. Glycols (of any type) shall not be discharged to the sanitary sewer. Dispose of in accordance with local, state and federal EPA requirements.
- D. Wastewater containing any chemical or sediment is prohibited from discharge to the storm water system. No chemical shall contain Chromates or Inorganic Phosphates.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package for delivery to best protect finished surfaces while using the least amount of single-use packaging as possible. Deliver equipment and components adequately packaged for lifting, skidding, or rolling into final position, according to manufacturer's instructions. If possible, package and ship products using reusable blankets and fabrics, or reusable cardboard and crate systems.
- B. Store materials and equipment raised off the floor on pallets and protected with coverings to prevent damage due to weather and construction activities. Store in areas that prevent damage due to freezing and extreme temperatures or sunlight. Arrange coverings to provide air circulation to avoid damage from condensation or chemical build-up. Protect from damage, dirt and debris at all times.
- C. Store chemicals in curb protected area. Such secondary containment areas must have the capacity to hold the volume of the largest container or 10% of the combined containers, whichever larger. If room has no floor drains, then the room itself may be considered sufficient secondary containment. If the room is considered the secondary containment ensure there is a lip at the door so no liquids can exit the room in the event of a leak. Verify field conditions before storing any chemicals
 1. Provide temporary containment areas when permanent containment areas do not exist. Remove temporary containment at the end of construction.

1.06 WARRANTY

- A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion. This warranty does not include ongoing chemical treatment or monitoring.

1.07 ACCEPTABLE CHEMICAL SERVICE PROVIDERS (CSPS)

- A. CSP shall be regularly engaged in HVAC water treatment services for other facilities within a 150 mile radius of project site.
- B. Subject to compliance with project requirements available CSPs may include, but are not necessarily limited to the following vendors:
 1. Industrial Solutions, Inc.
 2. Innovative Water Treatment, LLC.
 3. Nalco Water, an Ecolab Company
 4. Rocky Mountain Aquatech, Inc

PART 2 - PRODUCTS

2.01 GENERAL

A. CSP Services:

1. The CSP shall provide all cleaning and treatment chemicals, basic services, testing, equipment and materials necessary for a complete water treatment program.
2. The CSP shall perform an analysis of the supply water to determine the type and quantities of chemical treatment needed to maintain the required water quality to prevent corrosion, scaling, and biological growth. The CSP will at minimum provide weekly site visits to verify proper water treatment for the first month after any system or part of a system is treated. Provide monthly visits thereafter, or more often if required to assure performance requirements are being met, to analyze water samples, inspect equipment, and add additional chemicals as required to maintain proper water treatment, until final written Owner acceptance of the respective system.
3. At each site visit CSP shall analyze each system for corrosion inhibitors, pH, total iron, total copper, bacteria levels (provide monthly analytical laboratory analysis), and conductivity; inspect loss from corrosion coupons (provide analytical laboratory analysis every three months), record make-up meter readings, and perform any other tests necessary to validate that corrosion, scale, and organic growth is being prevented.
4. Reports:
 - a. Submit a written startup test report for each system placed into service.
 - b. A service report shall be prepared on site by the CSP, submitted at the time of each service visit (with copies immediately provided to the Owner and Commissioner), which shall include all required test results and recommendations.
 - c. Additionally, provide final reports for approval to the Owner and Commissioner regarding each site service visit, certified by an Officer of the CSP, within one week of any water treatment activity. Such reports shall include the results of any field or lab tests. Reports shall clearly state if the required water quality and maximum corrosion rates are being achieved.
 - d. At a minimum, each report shall include the following information:
 - 1) System Treated:
 - 2) Date
 - 3) Conductivity
 - 4) pH
 - 5) Total Iron
 - 6) Total Copper
 - 7) Bacteria(cfu) (monthly analytical laboratory analysis)
 - 8) Coupon Corrosion Rates (three month analytical laboratory analysis)
 - 9) Make-up Water Quantity since Last Visit
 - 10) Corrosion Inhibitor level (ppm)
 - 11) Silica level (ppm)
5. Conduct final on-site system turn over meeting with Owner and Commissioner. Present final validation report demonstrating that performance requirements have been achieved and that each system is currently properly treated.
6. When required by Part 3, train Owner's maintenance personnel in water treatment procedures.
7. Program Administration Manual:

- a. The CSP shall provide the Owner with two (2) Program Administration Manuals including sections covering program control, testing requirements, in plant logs, safety data and system information. Each section shall include the following:
 - 1) Program Control: Include a complete program outline with chemical descriptions, control ranges, and required action for “out of range” situations. Also include complete ordering instructions with applicable account numbers and phone numbers.
 - 2) Testing Requirements: This section will include basic testing practices as well as detailed test instructions for each test to be performed.
 - 3) In-Plant Logs: Include detailed testing log sheets for each system to be tested including room to record one (1) month’s data on one (1) sheet and a section to log chemical inventory.
 - 4) Safety Data: Include the CSP’s 24-hour toll free safety hotline number as well as MSDS sheets for each chemical used.
 - 5) System Information: Include any equipment manuals and related information.

2.02 TREATMENT PROGRAM - FLUSHING AND CLEANING

- A. Cleaning chemicals shall be non-phosphate and non-acidic.
- B. Flush and clean all new and reused piping.
- C. Provide a flush/clean plan for approval. Provide and later remove all temporary bypasses, drains, vents, etc. required to flush and clean the system. Temporary components for flushing and cleaning are not indicated on the drawings.
- D. Flush and clean systems per the general procedures specified in Related Sections; clean systems per the approved cleaning procedures submitted under this specification section. Provide and install all required cleaning chemicals.
- E. Verify that adequate cleaning chemical was added, that cleaning was effective, and test that cleaning chemicals were properly rinsed from the system. Provide a report certifying that cleaning and rinsing, was properly executed.
- F. Provide passivation and chemical treatment immediately after each system has been cleaned and flushed. Systems shall not stand filled with fluids for periods longer than 48 hours without beginning flushing and cleaning which shall immediately be followed by the passivation and chemical treatment procedures.

2.03 TREATMENT PROGRAM - CHEMICAL TREATMENT AND PASSIVATION

- A. Provide passivation and chemical treatment per the approved chemical treatment procedures. Chemically treat new and reused piping networks using chemicals and treatment procedures compatible with the system being cleaned and the chemical treatment chemicals in existing piping systems being connected to. Test existing piping systems or otherwise determine chemical treatment in existing piping and validate compatibility. Note that existing systems may be silica based, adjust water treatment program accordingly.
- B. When connecting into active existing systems, treat piping networks installed or reused by the project and verify by lab analysis that the treatment levels per the treatment plan have been

attained prior to connecting into the existing active system. Submit validating report for approval.

1. Do not connect into existing active system until report is approved by Owner.
 2. Provide temporary valves, piping, and accessories as required to treat the project's piping prior to connection to the active system.
- C. Provide passivation/chemical treatment at system startup or immediately upon operation of a system for temporary cooling and heating, whichever comes first.
- D. Provide chemical treatment immediately after each system has been cleaned and flushed. Thereafter immediately begin the approved water treatment maintenance program to passivate and prevent corrosion, scale, and organic growth and to maintain treatment chemical levels. Note that systems or parts of systems will not typically be started at the same time; adjust treatment strategy accordingly.
- E. Provide chemicals that comply with State and Federal regulations.
- F. Chemical inhibitor shall be polymer based and contain azole in an amount appropriate for the percentage of internal copper surface area of the system piping. Provide products with PTSA (p-Toluenesulfonic acid) florescent tracer dyes. Molybdenum shall not be used as a tracer. Optionally, for hot water heating systems only, nitrite/azole based inhibitors may be used.
- G. No chemicals shall contain chromates or inorganic phosphates.
- H. Utilize non-oxidizing biocides in the event sterilization is required.
- I. Adjust chemical concentrations as required to achieve the required performance

2.04 PERFORMANCE REQUIREMENTS

- A. The water treatment programs proposed by the CSP shall maintain corrosion rates below 0.5 mils per year for mild steel and 0.1 mils per year for copper. These rates shall be verified with corrosion coupons provided by the CSP. Coupons shall be analyzed in the CSP's analytical laboratory every three months, more often if required, to assure these levels are not exceeded.
- B. Microbiological growth levels shall be maintained below 10,000 cfu's aerobic bacteria and 10 cfu's anaerobic bacteria. The CSP shall perform detailed microbiological culturing at the CSP's company's analytical laboratory monthly, more often if required, to assure these levels are not exceeded

2.05 EQUIPMENT

- A. Provide all components required for a fully operational water treatment system. Provide components that are not adversely affected by the treatment chemicals employed.
- B. Chemical Shot Feeders:
1. Acceptable Manufacturers:
 - a. Griswold Controls.
 - b. J.L. Wingert Company
 - c. Neptune, a brand of the Dover Company.

2. Provide shot feeders for each system. Provide steel 5-gallon minimum tank with interior and exterior epoxy coating, removable screwed and gasketed top (4" diam. minimum), pipe threaded inlet and outlet, dish bottom style with floor skirt, rated at 200 psi, 200°F.
- C. Corrosion Coupon Rack:
1. Acceptable Manufacturers:
 - a. Cannon Water Technology
 - b. J.L. Wingert
 - c. Vector Industries
 2. Supply for each corresponding shot feeder:
 - a. Runaround Loop: 3/4 inch stainless steel coupon rack, with two coupon holders, inlet/outlet 316 stainless steel full port ball valves, and a 1/4 inch sample valve. Include a 0-5 gpm nominal range variable area flow meter, rated 150 psig at 70 deg F, with graduated polysulfone or acrylic cylinder, with an accuracy of +/-5%. Provide mild steel and copper coupons.
- D. Glycol Feed System:
1. Acceptable Manufacturers:
 - a. J.L. Wingert Company.
 - b. Neptune Chemical Pump Co.
 - c. Advantage Controls Inc.
 - d. Wessels Co.
 2. Provide a floor mounted packaged glycol feed system that is pre-wired and pre-plumbed, and includes a storage tank, control panel, controls, pump, piping, and valves, all supported on a steel frame.
 3. Provide a 50-gallon minimum translucent polyethylene single wall tank with polyethylene cover. Minimum 1/4-inch-thick walls.
 4. Provide a welded steel stand suitable for floor mounting and painted with two coat system consisting of oxide primer and alkyd enamel finish. Provide holes in the base for the installation of anchor bolts and leveling of equipment.
 5. Provide a bronze gear pump, 120 V, single phase, and rated for a minimum of 1.5 gpm at 90 psig.
 6. Valves and Piping: Pump suction shall include ball valve and Y-strainer. Pump discharge shall include silent check valve, pressure switch, pressure gauge, and 150 psi relief valve piped back to tank. All piping shall be Type L Copper. Connect pump suction and discharge with braided stainless steel or bronze flex connectors. All piping, valves and accessories shall conform to Related Sections.
 7. Provide a NEMA 4X control panel with 8 foot, 120 V grounded power cord. Equip the panel with motor starter, 2-position main power switch with light, hand /off/ auto switch with light for gear pump, low level red light, low level audible alarm with push button silence switch, dry contacts for remote monitoring of alarm, and a 15 amp fuse.
 8. Provide an adjustable pressure switch, selected with a range to match system operating pressure.
 9. Provide electrical components that conform to Division 26 requirements. Provide all wiring in conduit. Loose, exposed or unprotected wire is not acceptable

2.06 INHIBITED PROPYLENE GLYCOL

- A. Acceptable Manufacturer and Product:

1. Dow Chemical - Dowfrost TM
- B. Provide for closed loop heating and chilled water hydronic systems as indicated on the drawings.
- C. Provide inhibited propylene glycol, mixed with softened water at a concentration of 35% by volume for the runaround energy recovery loop for burst protection down to 60 deg F below zero. Provide charts, tables, and/or graphs indicating freeze and burst protection for all glycol percentages as part of product submittal data sheets.

3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Pre-Treatment Conference: Prior to treatment activities, meet with the Project Engineer, Commissioner and contractors to verify treatment procedures, discuss coordination with existing piping networks, and to coordinate treatment activities with construction schedule.
- B. Flush and clean systems per Related Sections and Part 2 above.

3.02 INSTALLATION

- A. Install all required components, and chemically passivate/treat and maintain the system as described in Part 2.
- B. Use and dispose of chemicals and wastewater (including from existing piping networks) per the Quality Assurance section of this specification. All costs of disposal shall be borne by the contractor.
- C. Provide and install all chemicals and all incidental components. Install equipment at locations shown on the Drawings. Follow the manufacturer's installation and startup instructions.
- D. Passivate and chemically treat each system immediately after it has been cleaned and flushed.
- E. Install shot feeders with openings no higher than 4' above finished floor. Pipe shot feeder drain to nearest floor drain. Install top coupon of corrosion coupon rack no higher than 6' above finished floor.
- F. The treatment program shall begin at system start-up or immediately upon first operation of the system by the contractor for temporary heating and cooling, whichever comes first. Continue the program until Substantial Completion.

3.03 INSTALLATION OF INHIBITED PROPYLENE GLYCOL SYSTEM

- A. Following system flushing and cleaning, drain the entire piping system. Add propylene glycol/water and inhibitor solution into the system. Circulate system fluid, adding additional propylene glycol/inhibitor as required until all air is purged from the system.
- B. Sample fluid, measure concentration of glycol and inhibitor. Drain system fluid as required and add additional solution to achieve the design concentration of glycol and the manufacturer's

recommended concentration of inhibitor. Submit report of activities, including volumes of all fluids used.

3.04 INSTALLATION OF GLYCOL FEED SYSTEM

- A. Level and bolt Glycol Feed System to the shop keeping pad. Support all piping and conduits independent of the Glycol Feed Unit. Provide initial fill of Feed unit reservoir.

3.05 FIELD QUALITY CONTROL:

- A. The CSP shall:
 - 1. Verify that systems and equipment have been properly cleaned, flushed, and filled with water, and are fully operational before introducing operational chemicals for water-treatment systems.
 - 2. Introduce and maintain chemical treatment to achieve the specified performance requirements.
 - 3. Submit a written startup test report for each system placed into service.
 - 4. Provide validation testing and required reports.
 - 5. Attend final on-site system turn over meeting with Owner and Commissioner. Present final validation report demonstrating that performance requirements have been achieved and that each system is currently properly treated.

3.06 COMMISSIONING:

- A. Perform Commissioning activities per Related Sections above.

3.07 OWNER TRAINING

- A. CSP shall train Owner's maintenance personnel on equipment operation, adding and maintaining proper chemical levels, trouble-shooting, servicing and preventative maintenance procedures. Do not conduct training until after start up and commissioning is completed. Provide training using documents including the Program Administration Manual and the approved Operations and Maintenance manuals. Provide these documents to the Owner at least two weeks prior to the training to allow sufficient time for review.
 - 1. Provide 2 hours training minimum.
- B. Schedule training at least 7 days in advance, at date and time approved by Owner.

END OF SECTION 232513

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SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.
 - 7. Seismic-restraint devices.
- B. Section includes the following systems:
 - 1. Supply Duct
 - 2. Return Duct
 - 3. Exhaust Duct
 - 4. Outside Air Duct
 - 5. Dryer and Ironer Exhaust

1.03 Related requirements

- A. Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
- B. Section 23 3116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
- C. Section 23 3119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
- D. Section 23 3300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

- B. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.
- F. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).
- G. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- I. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020.
- K. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- L. AWS D9.1/D9.1M - Sheet Metal Welding Code; 2018.
- M. NADCA ACR - The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC Systems; 2025.
- N. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Revised 2009).
- O. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.
- P. SMACNA (OCC) - IAQ Guidelines for Occupied Buildings Under Construction; 2007.
- Q. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.
- R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.05 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA (DCS) and performance requirements / design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA (DCS) and SMACNA (SRM)

- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1 ASHRAE 62.1.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Sealants and gaskets.
 - 2. Seismic-restraint devices.
 - 3. Duct materials and construction.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.07 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:

- a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- B. Welding certificates.

1.08 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M for hangers and supports; AWS D1.2/D1.2M for aluminum supports at specialty duct locations in Kitchens and/or Natatoriums, and AWS D9.1/D9.1M for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE Std 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE Std 90.1 I-P, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA (DCS) based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA (DCS), Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA (DCS), Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA (DCS), Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).

2.03 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA (DCS), Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lindab Inc
 - 2. McGill AirFlow LLC
 - 3. SEMCO Incorporated .
 - 4. Sheet Metal Connectors, Inc
 - 5. Spiral Manufacturing Co., Inc
 - 6. Submit request for substitutions in accordance with Instructions to Bidders and Division 01 General Requirements.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- D. Transverse Joints: Select joint types and fabricate according to SMACNA (DCS), Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA (DCS), Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- F. Tees and Laterals: Select types and fabricate according to SMACNA (DCS), Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA (DCS).

2.04 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA (DCS) for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal

materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" or elsewhere. Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.05 DUCT LINER - Prohibited.

2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- D. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA (DCS), Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.08 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service, the Office of Statewide Health Planning and Development for the State of California, or other agency acceptable to authorities having jurisdiction.
- B. Restraint Cables: ASTM A603, galvanized or ASTM A492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- C. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA (DCS) unless otherwise indicated.

- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults, electrical equipment rooms and enclosures, and IT equipment rooms.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 3300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA (OCC), Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA (DCS).

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA (DCS), Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA (DCS), Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hanger straps shall be a minimum of 24 gauge.
- E. Hangers Exposed to View: Threaded rod and angle or channel supports.
- F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA (SRM) and ASCE 7.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- F. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA (DCS) for branch, outlet and inlet, and terminal unit connections.

3.07 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- B. Paint exterior of metal ducts that are exposed to finish space. Duct shall be constructed of Paint grip metal.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 1. Comply with SMACNA (LEAK). Submit a test report for each test.
 2. Test the following systems:
 - a. Supply Ducts with a Pressure Class of 4-inch wg or Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 2-inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Exhaust Ducts with a Pressure Class of 2-inch wg or Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.
 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 4. Test for leaks before applying external insulation.
 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 6. Give seven days' advance notice for testing.

- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR.
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.09 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 3300 "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Supply Ducts:
 1. Low Pressure Supply Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and downstream of Terminal Units:
 - a. Pressure Class: Positive 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg or system design pressure indicated in equipment schedule, whichever is greater..
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3".
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
 3. Ducts Connected to Variable-Air-Volume Air-Handling Units (Medium Pressure Supply) and Energy Recovery Ventilator supply:
 - a. Pressure Class: Positive 4-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A.

- d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
- B. Return Ducts:
- 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Inlet Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
- C. Exhaust Ducts:
- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A where under positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12 if negative pressure, and 6 where under positive pressure.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6 if under negative pressure, and 3 where under positive pressure.
 - 2. Ducts Connected to Air-Handling Units and Energy Recovery Ventilators:
 - a. Pressure Class: Positive or negative 3-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or Negative 2-inch wg or system design pressure indicated in equipment schedule, whichever is greater.
 - b. Minimum SMACNA Seal Class: B for 3" or less and A for greater than 3" ..
 - c. SMACNA Leakage Class for Rectangular: 12 for Class B and 6 for Class A.

- d. SMACNA Leakage Class for Round and Flat Oval: 6 for Class B and 3 for Class A.
- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 - 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 3. Aluminum Ducts: Aluminum.
- E. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA (DCS), Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA (DCS), Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA (DCS), Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Rectangular Duct: Comply with SMACNA (DCS), Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA (DCS), Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 3. Round Duct: Comply with SMACNA (DCS), Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA (DCS), Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Welded.
- F. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA (DCS), Figure 4-6, "Branch Connection."

- a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
- 2. Round and Flat Oval: Comply with SMACNA (DCS), Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

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SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Fire dampers.
 - 5. Combination fire and smoke dampers.
 - 6. Duct silencers.
 - 7. Turning vanes.
 - 8. Remote damper operators.
 - 9. Duct-mounted access doors.
 - 10. Flexible connectors.
 - 11. Flexible ducts.
 - 12. Duct accessory hardware.
- B. Related Requirements:
 - 1. Division 26 Section "Fire Detection and Alarm"

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.03 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product : Subject to compliance with requirements, provide product indicated on Drawings or specified herein or comparable product by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc
 - 2. Nailor Industries Inc
 - 3. Ruskin Company
- C. Description: Gravity balanced.
- D. Maximum Air Velocity: 1000 fpm.
- E. Maximum System Pressure: 6-inch wg.
- F. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- G. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- H. Blade Action: Parallel.
- I. Blade Seals: Neoprene, mechanically locked.
- J. Blade Axles:
 - 1. Material: Galvanized steel .
 - 2. Diameter: 0.20 inch.
- K. Tie Bars and Brackets: Galvanized steel.
- L. Return Spring: Adjustable tension.
- M. Bearings: Steel ball or synthetic pivot bushings.
- N. Accessories:
 - 1. Electric actuators.

2.05 MANUAL VOLUME DAMPERS

- A. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc
 - b. McGill AirFlow LLC
 - c. Nailor Industries Inc
 - d. Ruskin Company
 2. Comply with AMCA 500-D testing for damper rating.
 3. Low-leakage rating[, with linkage outside airstream,] and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 4. Suitable for horizontal or vertical applications.
 5. Frames:
 - a. Hat shaped.
 - b. 0.094-inch- thick, galvanized sheet steel .
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 7. Blade Axles: Stainless steel.
 8. Bearings:
 - a. Oil-impregnated stainless steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 9. Blade Seals: Neoprene.
 10. Jamb Seals: Cambered aluminum.
 11. Tie Bars and Brackets: Galvanized steel.
 12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- B. Jackshaft:
1. Size: 1-inch diameter.
 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.
 3. Include elevated platform for insulated duct mounting.

2.06 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation
 - 2. McGill AirFlow LLC
 - 3. Pottorff
 - 4. Ruskin Company
 - 5. Young Regulator Company
- B. Low-leakage rating[, with linkage outside airstream,] and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat shaped.
 - 2. 0.094-inch- thick, galvanized sheet steel.
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches.
 - 2. Parallel- and opposed -blade design.
 - 3. Galvanized-steel .
 - 4. 0.064 inch thick single skin.
 - 5. Blade Edging: Closed-cell neoprene.
- E. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
 - 1. Oil-impregnated bronze .
 - 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

2.07 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc
 - 2. Greenheck Fan Corporation
 - 3. Nailor Industries Inc
 - 4. Ruskin Company
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 or 3 hours.

- E. Frame: Curtain type with blades outside airstream ; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.39 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.08 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc
 - 2. Greenheck Fan Corporation
 - 3. Nailor Industries Inc
 - 4. Ruskin Company
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 or 3 hours.
- E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Heat-Responsive Device: resettable device and switch package, factory installed, rated.
- G. Smoke Detector: Integral, factory wired for single-point connection.
- H. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.
- I. Leakage: Class II.
- J. Rated pressure and velocity to exceed design airflow conditions.
- K. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- L. Master control panel for use in dynamic smoke-management systems.
- M. Damper Motors: Modulating or two-position action depending on location. Units that are also used for HVAC control are typically modulating while all others are typically two-position.

- N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 0900 "Instrumentation and Control for HVAC."
 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 7. Electrical Connection: 115 V, single phase, 60 Hz.
- O. Accessories:
1. Auxiliary switches for signaling position indication.
 2. Momentary test switch Test and reset switches, damper mounted.

2.09 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price Industries
 2. Industrial Noise Control, Inc.
 3. Ruskin Company.
 4. Vibro-Acoustics
- B. General Requirements:
1. Factory fabricated, with internal polymer liner making silencer suitable for Hospital setting.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Shape:
1. Rectangular straight with splitters or baffles.
 2. Round elbow with center bodies or pods.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.040 inch thick.

- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.
 - 1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
 - 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
 - 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
 - 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.
- F. Inner Casing and Baffles: ASTM A 653/A 653M, G60 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.
- G. Special Construction:
 - 1. Suitable for outdoor use.
 - 2. High transmission loss to achieve STC 45.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Film-lined type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: Polymer suitable for hospital patient care application.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Joints: continuously welded or flanged connections.
 - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Source Quality Control: Test according to ASTM E 477.
 - 1. Testing of mockups to be witnessed by Architect.
 - 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc
 - 2. Duro Dyne Inc
 - 3. METALAIRE, Inc
 - 4. SEMCO Incorporated
- B. Manufactured Turning Vanes for Metal Ducts: Curved air foil blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.11 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Pottorff
 2. Ventfabrics, Inc
 3. Young Regulator Company
 4. **Durodyne**
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Cable: Stainless steel.
- D. Wall-Box Mounting: ~~Not applicable. Operator accessible through register face.~~ **High/Medium Risk Registers: Mount and label wall boxes in accessible area of ceiling plenum. Operators for low risk registers may be located in the face.**

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc
 2. Flexmaster U.S.A., Inc
 3. Greenheck Fan Corporation
 4. McGill AirFlow LLC
 5. Nailor Industries Inc
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

- b. Access Doors up to 18 Inches Square: Two hinges or Continuous and two sash locks.
- c. Access Doors up to 24 by 48 Inches: Three hinges or Continuous and two compression latches[with outside and inside handles.
- d. Access Doors Larger Than 24 by 48 Inches: Four hinges or Continuous and two compression latches with outside and inside handles.

2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc
 - 2. Duro Dyne Inc
 - 3. Ventfabrics, Inc
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 incheswide attached to two strips of 2-3/4-inch-wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.14 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc
 - 2. McGill AirFlow LLC
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with duct insulation value specified for associated system in Division 23 Section HVAC Insulation..
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.15 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Connect ducts to duct silencers with flexible duct connectors .
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment. Access doors not required downstream of volume dampers that serve a single air inlet or outlet register.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.

8. Upstream and downstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 23 0553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect terminal units to supply ducts directly. Flexible duct connections on the upstream of supply terminal units are not permitted. Flexible duct connections on the downstream side of exhaust and return terminal units are not permitted. Do not use flexible ducts to change directions. Minimum straight length of duct upstream of supply terminal units shall be no less than five (5) duct diameters.
- O. Connect diffusers or light troffer boots to ducts directly for return/exhaust inlets and with maximum 96-inch lengths of flexible duct clamped or strapped in place for supply outlets.
- P. Connect flexible ducts to metal ducts with stainless steel worm drive clamp plus tape.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. **For inaccessible Supply, Return and Exhaust duct which require balance dampers, provide remote dampers operator with wall boxes located in an accessible portion of the ceiling plenum. Inaccessible shall be defined as any branch balance damper more than 3 feet from any ceiling access panel. Mount wall boxes to structural hanger and label with room name. Gang as many boxes together in one location and note on as-builts drawing locations. Ensure cable operators are fully functional for required balancing.**
- 3.02 FIELD QUALITY CONTROL
- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 3300

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SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. In-line centrifugal fans.

1.03 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations sea level.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Fan speed controllers.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators[and seismic restraints] and for designing vibration isolation bases.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.08 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering & Manufacturing Corporation
 - 2. Aerovent; a division of Twin City Fan Companies, Ltd
 - 3. Carnes Company
 - 4. Greenheck Fan Corporation
 - 5. Loren Cook Company
 - 6. PennBarry
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 3. Companion Flanges: For inlet and outlet duct connections.
 - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
- E. Capacities and Characteristics: See Drawings

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.03 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 - 1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in [Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Support suspended units from structure using threaded steel rods and elastomeric hangers spring hangers spring hangers with vertical-limit stops Insert device having a static deflection of 1 inch Vibration-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

- D. Install units with clearances for service and maintenance.
- E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

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SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Single-duct air terminal units.
- B. Related Requirements:
 - 1. Section 23 3616 "Critical Environment Air Terminal Units" for additional requirement for supply and return/exhaust tracking terminal units associated with PPE rooms.

1.03 ACTION SUBMITTALS

- A. Coordination Drawings: Full 3D coordination is required prior to starting construction. For project requirements see Section 23 0010 - HVAC (Heating, Ventilation and Air Conditioning) General Provisions
- B. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Sealants and gaskets.
- C. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- D. Delegated-Design Submittal:
 - 1. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.

2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
1. Instructions for resetting minimum and maximum air volumes.
 2. Instructions for adjusting software set points.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.07 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, Available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the listed manufacturers in the following sections. Where a specific manufacturer's product has been contemplated as the basis of design, that manufacturer has been listed in the equipment schedules on the Drawings or other Sections in this Specification. Where a basis of design is contemplated but other Available Manufacturer desired to be utilized, the proposed material or equipment shall be identical to the specified material or equipment in all characteristics of quality, function, capacity, efficiency, spatial criteria and serviceability, regardless of application in the Project and, in addition, when the Architect deems that aesthetic significance is important, the equal material or equipment must be identical in all characteristics of visual appearance, design, color and texture.
- B. Equipment Categories: Equipment types in this section are considered equipment categories that be furnished by one manufacturer or available through one manufacturer to provide consistency within the overall project for equipment configurations, manufacturing techniques, and to facilitate ease of maintenance for the Owner.

2.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", ASCE/SEI 7, and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".

2.03 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. With the exception of Critical Environment air terminal units, all VAV boxes are based on Price SDV.
 - 2. Provide silencer for critical environment terminal units (including supply, return and exhaust) specified in Section 23 3616.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, double wall.
 - 1. Casing Lining: Adhesive attached, 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - a. Cover liner with nonporous inner wall of double wall casing.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections[, size matching inlet size].
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Attenuator Section: 0.034-inch steel sheet.
 - 1. Lining: Adhesive attached, 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - a. Cover liner with polymer film suitable for hospital application and perforated metal inner wall.
- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

- G. Accessories: Factory mounted transformer and line voltage junction box to transform 277 Volt, single phase power to 24 Volt, single phase control power at each air terminal unit. EC to provide disconnect switch and connection at line voltage factory mounted junction box.
- H. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 23 0920 "Control Systems". ~~0900 "Instrumentation and Control for HVAC."~~

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.02 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Section 23 2113 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, and union or flange; and to return with balancing valve, control valve and union or flange.
- C. Connect ducts to air terminal units according to Section 23 3113 "Metal Ducts."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 3300 "Air Duct Accessories."

3.03 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 0553 "Identification for HVAC" for equipment labels and warning signs and labels.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Air terminal unit will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.05 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 3600

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SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. Section Includes Supply diffusers, Return and Exhaust registers and grilles for HVAC service.
- B. Related Sections:
 - 1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 23 3410 - Circulation Fans

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Refer to Schedules on Drawings for Basis of Design Products. Titus, Price and Krueger considered acceptable manufacturers not requiring prior approval for all standard grille, register and diffuser locations. Refer to substitution procedures in Division 01

2.02 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 PAINTING

- A. Paint all sheetmetal surfaces behind non-ligature resistant grilles, registers and diffusers matte black prior to device installation. See Section 23 3410 - Circulation Fans for specifications

3.04 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

SECTION 23 8219 - FAN COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. This Section includes fan-coil units and accessories.
- B. Related sections:
 - 1. Section 23 0548 - Vibration and Seismic Controls for HVAC
 - 2. Section {id#1000047} - {t#1000047}

1.03 DEFINITIONS

- A. BAS: Building automation system.

1.04 SUBMITTALS

- A. Coordination Drawings: Full 3D coordination is required prior to starting construction. For project requirements see Section 23 0010 - HVAC (Heating, Ventilation and Air Conditioning) General Provisions
- B. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Section 23 0548 - Vibration and Seismic Controls for HVAC Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- E. Field quality-control test reports.
- F. Warranty: Special warranty specified in this Section.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- 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. Fan-Coil-Unit Filters: Furnish Two spare filters for each filter installed.
 - 2. Fan Belts: Furnish Two spare fan belts for each unit installed.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.08 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.01 DUCTED FAN-COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Environmental Technologies, Inc
 - 2. International Environmental Corporation
 - 3. Daikin

4. Trane
 5. or Approved Equal
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Drain Pans: Stainless steel, insulated with plastic liner.. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
- E. Cabinets: Double wall steel with baked-enamel finish in manufacturer's standard paint color.
1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated Cotton-Polyester Media: > 90 percent arrestance and MERV 8.
- G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multi-speed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- I. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
1. Motors: Comply with requirements in Section 23 0513 - Common Motor Requirements for HVAC Equipment
- J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Two -way, modulating control valve for chilled-water coil.
 2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 36 inches.
 - b. Minimum Diameter: Equal to fan-coil-unit connection size.
 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
 5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston

- spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure, with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 7. Wrought-Copper Unions: ASME B16.22.
- K. BAS Interface Requirements:
1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation.
 3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan-coil-unit start, stop, and operating status.
 - c. Data inquiry including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- L. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- M. Capacities and Characteristics: See schedules on drawings.

2.02 NON-DUCTED FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Environmental Technologies, Inc
 2. International Environmental Corporation
 3. Daikin
 4. Trane
 5. or Approved Equal
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Drain Pans: Stainless steel, insulated with plastic liner.. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- D. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
- E. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
1. Vertical Unit Front Panels: Removable, steel, with integral discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with cast-aluminum discharge grilles.
 3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard color. Return grille shall provide maintenance access to fan-coil unit.

4. Steel recessing flanges for recessing fan-coil units into ceiling or wall
- F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 1. Pleated Cotton-Polyester Media: > 90 percent arrestance and MERV 8.
- G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multi-speed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- I. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 1. Motors: Comply with requirements in Section 23 0513 - Common Motor Requirements for HVAC Equipment
- J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 1. Two -way, modulating control valve for chilled-water coil.
 2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 36 inches.
 - b. Minimum Diameter: Equal to fan-coil-unit connection size.
 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
 5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure, with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 7. Wrought-Copper Unions: ASME B16.22.
- K. BAS Interface Requirements:
 1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation.
 3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan-coil-unit start, stop, and operating status.
 - c. Data inquiry including supply- and room-air temperature.

- d. Occupied and unoccupied schedules.
- L. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- M. Capacities and Characteristics: See schedules on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
- D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 8219

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SECTION 26 0005 - ELECTRICAL PROJECT MANAGEMENT REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL requirements

- A. All equipment and material specified and noted on the drawings is set as a minimum standard for the contractor to work to. All submitted tenders shall be based on material and equipment as specified. Equipment and material suppliers other than those specified are to make a written submission for consideration as an equal or alternate along with any cost savings that may be realized as a result of using this equipment. Submission for consideration as an equivalent shall be made, along with technical information, a minimum of 5 business days before bid date.
- B. The contractor shall obtain all necessary permits and approvals and pay for all necessary fees or other costs associated with carrying out the work herein. The contractor is responsible for providing any and all certificates as required to ensure that the installation is in conformance with and has been approved by all authorities having jurisdiction. Any revisions and/or changes required by the authorized inspector shall be done without charge to the owner and shall be done so as not to affect schedule or the work of others. All permits shall be posted in a conspicuous place on site. Upon completion this contractor shall provide the owner with a certificate of final approval from all authorities involved in the scope of his work.
- C. The contractor shall provide all labor, material, supplies and equipment required to install, start-up, and commission all systems described herein. The contractor shall assure and demonstrate proper operation of all described systems and equipment to the owner.
- D. During construction the contractor shall ensure that all material and equipment is new (with the exception of used equipment furnished by owner) and meets or exceeds the quality as set out in the specified equipment and applicable codes. The installation of all equipment and materials shall be of the highest workmanship and quality. Attention to detail, safety, neatness, access for maintenance, durability, etc. is expected and required.
- E. The contractor shall keep fully informed on all Federal and State laws, local bylaws and regulations, and all ordinances and decrees of bodies or tribunals having any jurisdiction or authority which in any manner affects those engaged or employed on the work, or which in any way affects the conduct of the work. The contractor shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders and decrees in force at the time of award.
- F. The contractor shall hold harmless and indemnify the Owner and its representatives against any claim or liability arising from or based on the violation of any such law, bylaw, ordinance, regulation, order or decree whether by the contractor or his employees. Furthermore, the contractor agrees to indemnify and defend the Owner, its agents and employees, and hold it and them harmless from any and all lawsuits, claims, demands, liabilities, losses and expenses, including court costs and attorneys' fees, for or on account of any injury to any person, or any death at any time resulting from such injury, or any damage to any property, which may arise or which may be alleged to have arisen out of or in connection with the work covered by this contract, except to the extent that such loss results from the sole negligent act of the Owner.

- G. Should any dispute arise as to the quality or fitness of material or workmanship, the decision shall rest solely with the engineer, and shall be based on the requirements that all materials shall meet or exceed specification requirements, and workmanship shall be of the best quality, and what is usual and customary in erecting other buildings shall in no way enter into consideration.
- H. All existing materials claimed by the Owner, as noted on the drawings, shall be disconnected by the contractor and provided to the Owner as directed. All existing materials not claimed by the Owner shall become the property of the contractor. The contractor shall remove all salvaged material from the construction site as it is disconnected. Disposal of salvaged material shall be done in a legal and environmentally accepted manner.
- I. The prime contractor shall provide for a qualified project superintendent which shall be present at the job site during all times when work is occurring, regardless of the trade. Said person shall remain through-out completion of the project; and be responsible for quality assurance, coordination and review, adherence to the documents, etc. Sub-contractors are also encouraged to appoint a single supervisory person. All aspects of the work, including sub-contracted work, are considered an extension of the prime contractor's duties and responsibilities. Passive management of sub-contractors or their work is unacceptable. The Owner reserves the right to request replacement of the job-site superintendent if in their opinion management of the project is ineffective.

1.02 ALTERNATES

- A. Definition: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
- B. Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate. Execute accepted alternates under the same conditions as other work of the Contract.

1.03 CONTRACT MODIFICATION PROCEDURES

- A. Minor Changes in the Work: Engineer will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."
- B. Proposal Requests:
 - 1. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications
 - a. Within twelve (12) working days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time

necessary to execute the change. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made.

If requested, furnish survey data to substantiate quantities. Include costs of labor and supervision directly attributable to the change. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

2. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Engineer.

- a. 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. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities. Include costs of labor and supervision directly attributable to the change. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

- C. Proposal Request will be issued using AIA Document G709.
- D. Upon Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.
- E. Construction Change Directive: Engineer may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

1.04 PROJECT MANAGEMENT AND COORDINATION

- A. 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, that depend on each other for proper installation, connection, and operation.
- B. Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
- C. Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work.
- D. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than fifteen (15) days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

- E. Project Meetings: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
 - F. Requests for Interpretation (RFI): Immediately on discovery of the need for interpretation of the Contract Documents, prepare and submit an RFI in the form specified. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
 - G. Engineer's Action: Engineer will review each RFI, determine action required, and return it. Allow seven (7) for response of each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
 - 1. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to "Contract Modification Procedures." If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within ten (10) days of receipt of the RFI response. Review response and notify Engineer within seven (7) days if Contractor disagrees with response.
 - H. Advertisement for final payment shall commence within ten (10) days after acceptance of the project by the Owner and the engineer as substantially complete.
 - I. Final payment shall be made forty-one (41) days after completion of the advertisement for final payment if all items on the punch list have been corrected and all other requirements of the Contract Documents have been fulfilled.
 - J. If punch list items have not been addressed within this forty-one day period, the Owner may contract for outside services to complete the work, and may deduct such costs from the retainage amount.
- 1.05 CONSTRUCTION PROGRESS DOCUMENTATION
- A. Contractor's Construction Schedule: Submit copy of schedule for entire construction period within seven (7) days of contract execution. Submit electronic copy labeled to comply with requirements for submittals. Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first ninety (90) days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities
- 1.06 SUBMITTAL PROCEDURES
- A. Product Data, Shop Drawings, & Coordination Layouts: Provide information with submittals as required by Division 01 and supplemented by the requirements listed in Section 26 0010.
 - B. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. 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. Initial Review: Allow fifteen (15) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination: Resubmittal Review: Allow ten (10) days for review of each resubmittal.

- C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data. Mark each copy of each submittal to show which products and options are applicable.
- D. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable: Dimensions, Identification of products, Fabrication and installation drawings, Roughing-in and setting diagrams, wiring diagrams showing field-installed wiring, including power, signal, and control wiring, etc.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. Product Test Reports: Prepare written reports indicating 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.
- G. Construction phase submittals: Contractor shall submit electronic copies of all shop drawings and product data for equipment proposed and installation details, reroutings, etc per the coordination effort for this project to the engineer for review prior to ordering materials or equipment. Product data shall state capacities, sizes, etc. of all equipment and shall be certified. Include computer-based selections of project specific conditions where applicable. Clearly mark each shop drawing, catalog cut and/or specification sheet to indicate those products and features which are intended to be furnished. Engineer reserves the right to reject submittals that are inadequately or unclearly marked. Specifically indicate any deviations from the design intent. Engineer reserves the right to require correction at no extra cost for deviations not specifically indicated in the submittal. Review and approval of submittals shall not relieve the contractor from the responsibility to furnish equipment and materials of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents.
- H. Substitutes: Should engineer allow contractor to use equivalent equipment and materials from an approved manufacturer other than that specifically specified, in accordance with procedures above, the use of same does not relieve the contractor from confirming to other trades affected. All relevant information such as dimensions, electrical, weight, etc. Any necessary revisions as a result shall be paid for by this contractor. If the proposed equipment or necessary modifications are not to the satisfaction of the engineer that the end result will be the same the contractor shall provide the specified equipment at no additional cost to the owner.

- I. Record Documents: In addition to hard copy format, all material submitted as final record products, including approved Shop Drawings and submittals, shall be submitted to the Owner in its original electronic file format on compact disc or portable media device. Material may be scanned into electronic file format where necessary.

1.07 TEMPORARY FACILITIES

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to Owner, Engineer, testing agencies, and authorities having jurisdiction.
- B. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work. 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.
- D. Temporary power equipment and distribution for construction shall not occupy building spaces or block pathways that are designated for permanent installation of other trades according to design drawings.
- E. 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.
- F. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- G. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.
- H. If AC power systems or their backup systems serving telecommunications, computer equipment, or their associated HVAC equipment and controls are taken out of service, for any reason, the Contractor shall be responsible for providing temporary systems during the period when the AC power systems or their backup systems are out of service. The Contractor shall be responsible for providing temporary power to all loads being interrupted.
- I. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1.08 PRODUCT REQUIREMENTS

- A. See additional requirements in Section 26 0010.
- B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.
- C. Warranties:
 - 1. Refer to the Division 01 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
 - 2. Compile and assemble the warranties specified in Division 26, 27, and 28 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
 - 3. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
 - 4. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1.09 EXECUTION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, water-service piping, and underground electrical services.
- C. 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.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- E. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce

requirements strictly. Dispose of materials lawfully. 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.

1.10 CUTTING AND PATCHING

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least ten (10) days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information: Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided. Dates: Indicate when cutting and patching will be performed. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
- B. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
- C. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- D. 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 result in increased maintenance or decreased operational life or safety.
- E. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, which results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- F. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- G. 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.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1.11 SUBSTANTIAL COMPLETION

- A. As applied to this Contract, substantial completion shall be defined as follows: For the contract to be declared substantially complete; the specified/indicated electrical and technology systems, shall be fully operational and the interior and exterior of the structure shall be free from debris, such that the Owner may occupy the building and use it for its intended purpose. All adjusting, testing, certification, etc. as well as substantial completion submittals shall be completed.
- B. The contractor agrees that, to the extent possible, the Owner may deduct liquidated damages from the amount otherwise due the contractor and further agrees that, to the extent it is not possible to make such deductions from the amount otherwise due the contractor, the contractor will pay to the Owner the above mentioned sums.
- C. The substantial completion date upon which liquidated damages become payable shall be extended for any period of delay for unforeseeable cause beyond the control and without the fault or negligence of the contractor, including acts of God, or the public enemy, acts of the Owner, acts of another contractor in the performance of a contract with the Owner, fires, floods, epidemics, quarantines, restrictions, strikes, and freight embargoes.
- D. Notify proper authorities when work is ready for inspections required by applicable codes, rules and regulations, allowing sufficient time for inspections to be made without hindering progress of the work. Furnish to the Owner copies of inspection certificates of acceptance.
- E. The contractor, by entering into the Contract, agrees that:
 - 1. Time, so far as it relates to the substantial completion date, is essential to the Contract
 - 2. The Owner's actual damages due to the contractor's failure to complete the work on the proposed substantial completion date would be difficult and impractical to compute
 - 3. The liquidated damages amount constitutes a reasonable estimate of such damages and does not constitute a penalty.

1.12 CLOSEOUT PROCEDURES

- A. The contractor's attention is directed to the General and Supplementary Conditions of the Contract for specific instructions relative to the following:
 - 1. Record drawings and specifications
 - 2. Instruction of Owner's operating personnel
 - 3. Substantial completion and punch lists
 - 4. Operation and maintenance manuals
- B. Submit a written request for observation of installation for Substantial Completion. On receipt of request, Engineer will either proceed with observations or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after verification or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
- C. Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual. Provide additional copies of each warranty to include in operation and maintenance manuals.

- D. Final Cleaning: Clean all equipment, materials, walls, ceilings, floors, devices etc. of dirt, oil, dust and packaging material affected during the course of this work. Disconnect, clean and reconnect where necessary for the purpose of locating and removing obstructions. Remove all tools, waste material, trash, and packaging materials generated by this work from the site. Upon completion ensure all surfaces are cleaned of grease, dirt, etc. Once completed, the facility shall be available for immediate use.

1.13 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals: upon receipt of reviewed submittals, contractor shall immediately commence compiling operations and maintenance data manuals (O&M's). Submit O&M's for review no less than thirty (30) calendar days prior to submitting notice of substantial completion. O&M's shall contain at a minimum:
 - 1. Table of contents
 - 2. Tabbed dividers
 - 3. Index
 - 4. Construction phase submittals w/ engineer's review
 - 5. Systems descriptions
 - 6. Maintenance tasks
 - 7. List of contractors
 - 8. Equipment suppliers' parts lists, troubleshooting guides, and maintenance data
 - 9. Testing/inspection reports
 - 10. Identification directory
 - 11. Product warranties
- B. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.
- C. 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."
- D. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation

- G. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation for each component part or piece of equipment. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
- H. 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. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- I. 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
- J. Initial Submittal: Submit one (1) draft copy of each manual at least fifteen (15) days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Engineer will return copy of draft and mark whether general scope and content of manual are acceptable.
- K. Upon completion of review, submit two (2) copies neatly bound in 3-ring binders, tabbed, and labeled and (1) electronic copy with similar tabbing/book marking and organization for ease of navigation, in the same fashion as the hard copies.

1.14 PROJECT RECORD DOCUMENTS

- A. Maintain one set of blue- or black-line white prints of the Contract Documents and Shop Drawings. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Accurately record information in an understandable drawing technique. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
- B. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
- C. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- D. Mark important additional information that was either shown schematically or omitted from original Drawings.
- E. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- F. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

- G. 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 Engineer's reference during normal working hours.
- H. As-builts and record drawings: upon completion, contractor shall submit for review marked up record drawings indicating all dimensions, inverts, distances from structure, and all deviations of the as-built installation from the graphical representations on the contract documents. Upon completion of review, submit two (2) full size copies, bound and one (1) electronic copy.

1.15 DEMONSTRATION AND TRAINING

- A. Instruction Program: Submit electronic copy of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit copy of complete training manual(s) for Owner's use.
- B. Major systems that will require demonstration and training are listed in the individual sections. Outline list included here for quick reference only. Refer to applicable sections for complete requirements:
 - 1. Lightning Controls
 - 2. Building Fire Alarm and Voice Announcement
- C. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 PRODUCT

2.01 not used

PART 3 EXECUTION

3.01 NOT USED

END OF SECTION

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SECTION 26 0010 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

- A. Electrical layout drawings are diagrammatic. Refer to Architectural, Structural, Mechanical HVAC and plumbing, as well as any specialty or interiors packages and drawings for guidance on dimensions, ceiling heights, locations of ducts, pipes, structural members or other systems. Locate lighting fixtures symmetrically in proper relation to finished areas except where dimensioned on the drawings or located on reflected ceiling plans. Mounting details, fittings, offsets, and slopes are not necessarily shown. Prior to commencement of work, conclusively coordinate the detailed installation of the conduit and equipment with all ductwork, piping, cable trays, structural, structural elements, and other work of other trades. Utilize 3-dimensional modeling and clash detection software to produce clash free shop coordination drawings of all disciplines at scale of 1/4" = 1'-0". No additional costs will be considered for changes because of interference with the work of others, or with other work within the same division. This includes any additional material required to correct minor job conflicts for normally accepted procedures of all trades.
- B. Coordination of all MEP systems above ceilings, in walls and shafts, and exposed in the garage, on roof, and in mechanical rooms for lighting, ductwork, diffusers, piping, electrical, fire protection, etc. shall be completed by Contractor prior to any staking or installations. Contractor shall submit 1/4" scale coordination shop drawings on Architectural backgrounds showing all systems to be coordinated.
- C. Workmanship Warranty: Upon completion of the work the contractor shall furnish to the owner a written guarantee stating that the contract warrants all new material and equipment, and all associated work and components shall be free from defects and/or failure for a period of one (1) year from the date of project substantial completion or turnover of the building to owner, whichever occurs last. Duration in which equipment is placed into operation for start-up and functional testing that occurs prior to substantial completion or building turnover shall not count as time against the warranty period. Any and all materials, equipment, workmanship and labor found to be defective or that fails in any way is to be replaced or corrected at no additional cost to the owner during the warranty period.
- D. Prior to submitting a bid, each bidder shall carefully examine the bidding documents. Bring to the attention of the Architect, in writing; any discrepancies, ambiguities, inconsistencies, or errors therein that are discovered during examination of drawings. Further, all bidders shall examine the site, condition and all associated scopes of work that fall under this contract and determine all costs for the work are fully covered in their bid submission. Failure to request clarification during the bid period for any inadequacy, omission, or conflict shall not relieve contractor of responsibilities. Signing of the contract shall be considered to implicitly denote that the contractor has a thorough understanding of the full intent and scope of these construction contract drawings and specifications. The contractor shall become familiar with the building, structure and the works of the other trades involved. This contractor shall work and cooperate with the other trades to ensure a quality installation and minimize conflicts.

- E. The Contractor shall obtain, at the Contractor's expense, from the Architect or Engineer a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Architect and Engineer a written release of liability acceptable to the Architect and Engineer prior to receiving the electronic media.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- B. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26, Division 27, and Division 28. It expands and supplements the requirements specified in other sections of Division 01 through 50.
- C. All drawings and specifications are to be read in coordination with one another such that work shown on one set is binding to the other. Where a discrepancy exists within these contract documents, the specifications shall take precedence. Where a discrepancy exists within the specification, Contractor shall price the more expensive approach, and the details shall be worked out during construction.
- D. This specification is part of a comprehensive set of design drawings and specifications that include other engineering, architectural, and design disciplines. Installing contractor shall be responsible to review the full set of contract documents; including all drawings, specifications, and addenda, in conjunction with this drawing package to provide an efficiently sequenced and fully coordinated installation. Provide Coordination Drawings per specifications. Contractor bears the responsibility to provide any additional labor and materials that result from a lack of interdisciplinary coordination.
- E. Refer to Divisions 07 and 09 for sealing and firestopping requirements where raceways penetrate smoke, fire, and sound rated walls.
- F. Refer to Division 08 for electrified door hardware and equipment provided by other trades.

1.03 REFERENCE STANDARDS

- A. The latest editions of the following standards (including supplements and official interpretations) are minimum requirements (refer to jurisdictional authority for latest adopted editions):
 - 1. NFPA 70 - National Electrical Code (NEC).
 - 2. NFPA 72 – National Fire Alarm Code.
 - 3. NFPA 101 – Life Safety Code.
 - 4. NFPA 110 – Emergency Power Systems
 - 5. Conform to all applicable State and Local Codes.
 - 6. American National Standards Institute (ANSI).

7. Americans with Disabilities Acts (ADA) and American National Standards Institute (ANSI) 117.
 8. National Electrical Manufacturer's Association (NEMA).
 9. A.I.A. "Guidelines for Design and Construction of Hospital and Healthcare Facilities."
 10. Underwriter's Laboratories (UL).
 11. Insulated Cable Engineers Association (ICEA).
 12. International Building Code (IBC).
 13. International Mechanical Code (IMC).
 14. International Fire Code (IFC).
 15. Institute of Electrical and Electronic Engineers (IEEE).
- B. The complete installation shall comply with requirements of the utility (electrical and telephone) companies furnishing service to this installation. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent or conflict with the drawings and specifications

1.04 DEFINITIONS

- A. Definitions: "Provide" shall mean "furnish and install". "Furnish" means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application. "Install" means to join, unit, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation. The words "accept" or "acceptable" denote only that the equipment items are in general conformance with the design concept of the project
- B. The term "supply", "provide", "install", or "furnish" shall mean to supply and install all labor, materials, tools and equipment as may be necessary to install same for the complete and functional operation of the electrical systems for this project.
- C. Concealed: Concealed areas are those areas that cannot be seen by building occupants.
- D. Exposed: Exposed areas are all areas that are exposed to view by building occupants, including areas below counter tops, inside cabinets and closets, inside all equipment rooms, and areas outside the building exterior envelope, exposed to the outdoors.

1.05 QUALITY ASSURANCE

- A. Contractor Qualifications: An acceptable Contractor for the Work under this Division must have personnel with experience, training and skill to provide a practical working system. The Contractor shall furnish acceptable evidence of having installed not less than three systems of size and type comparable to this Project. All personnel installing equipment under this Division shall possess valid city, and State licenses for their skill level. Each Journeyman shall supervise no more than two apprentice helpers. Refer also to Owner's Special Conditions.
- B. The contractor shall keep fully informed on all Federal and State laws, local bylaws and regulations, and all ordinances and decrees of bodies or tribunals having any jurisdiction or authority which in any manner affects those engaged or employed on the work, or which in any way affects the conduct of the work. The contractor shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders and decrees in force at the time of award.

- C. Discrepancies: All drawings and specifications are to be read in coordination with one another such that work shown on one set is binding to the other. Documents are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's Project Manager in writing and ask for an interpretation. Any item/issue not clarified prior to bidding is understood to be priced as the more expensive option. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation at no additional cost to the Owner.
- D. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, clarify uncertainties with the Architect/Engineer prior to quotation.
 - 1. Clarification methods: At the time of bidding, bidders shall familiarize themselves with the drawings and specifications. Any questions, misunderstandings, conflicts, deletions, discontinued products, catalog number discrepancies, discrepancies between the equipment supplied and the intent or function of the equipment, etc., shall be submitted to the Architect/Engineer in writing for clarification prior to issuance of the final addendum and bidding of the project. Where discrepancies or multiple interpretations occur, the most stringent (which is generally recognized as the most costly) that meets the intent of the documents shall be enforced.
- E. Should any dispute arise as to the quality or fitness of material or workmanship, the decision shall rest solely with the engineer, and shall be based on the requirements that all materials shall meet or exceed specification requirements, and workmanship shall be of the best quality, and what is usual and customary in erecting other buildings shall in no way enter into consideration.

1.06 REQUIRED Submittals

- A. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:
 - 1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
 - 2. Construction means or methods
 - 3. Coordination of the work with other trades
 - 4. Construction safety precautions
- B. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.
- C. Coordination Drawings
 - 1. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and materials necessary to overcome congested conditions at no increase in contract sum. The Contractor's base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.

2. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.
3. Prepare and submit required coordination drawings showing major elements, components, and systems of equipment and materials in relationship with other building components. Prepare drawings to an accurate scale, large enough to indicate required detail, and showing the necessary dimensions. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.
4. Coordination drawings are informational submittals. Submit coordination drawings to Engineer for information only to document proper coordination of all portions of work and that coordination issues have been identified and resolved prior to submitting to the Engineer and prior to commencing construction in each affected area. The review of the coordination drawings by the Engineer does not constitute a relief of responsibility of the Contractor or a change to the contract documents. The Contractor shall have sole responsibility in developing a fully coordinated and integrated ceiling cavity.
5. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work.
6. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.
7. No release of any shop drawings or product submittals will proceed until a coordination drawing, meeting the requirements within these specifications, has been submitted and approved for every area of construction indicated on the Electrical and Technology plans.
8. Start of work constitutes a material requirement for the aforementioned Coordination Drawings. Contractor shall bear any and all costs associated with changes that are not specifically addressed on the Coordination Drawings that were reviewed by the Engineer of Record.
9. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attention to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

D. Product Data and Shop Drawings

1. See Section 26 0005 for additional requirements.
2. Provide submittal data and shop drawings as required for all major components. (Listed in individual sections.
3. Schedule of Values: Provide Preliminary Schedule of Values to Engineer with product data submittal. Provide a final Schedule of Values at close-out of project including updated values based on actual installation. Provide according to the following descriptions.
 - a. General Construction (total)
 - b. Mobilization/Demobilization
 - c. Demolition
 - d. Service Entrance Equipment
 - e. Power Distribution
 - f. Lighting - Interior
 - g. Lighting – Exterior
 - h. Lighting Controls

- i. Basic Materials/Devices/Equipment Connections
 - j. Emergency Generator
 - k. Power Transfer Equipment
 - l. Structured Cabling
 - m. Classroom Audio/Visual
 - n. Conference Room Audio/Visual
 - o. P.A./Sound/Intercom
 - p. Fire Alarm
 - q. Security
 - r. Testing, Acceptance, and Commissioning
 - 4. Coordination Drawings: See above.
- E. Substantial Completion
- 1. See Section 26 0005 for additional requirements.
 - 2. Equipment Settings Report: Where specifically identified or within individual Division 26 Sections or necessary for confirmation of products, submit Equipment Settings Report indicating final configurations and settings.
 - 3. Test Reports. (Commissioning as well as Listed in individual sections): Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
- F. Closeout Submittals
- 1. See Section 26 0005 for additional requirements.
 - 2. Software Licenses: Provide documentation of ownership under the owner's corporate name (coordinate with owner's representative for exact ownership wording) for Software Licenses provided as part of the work included under Divisions 26, 27, and 28. Include information for updates, subscription requirements if applicable, backup, support, login, passwords, date when purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.
 - 3. Owner maintenance materials (Listed in individual sections).
 - 4. O&M Manuals
 - 5. Signed off Substantial Completion Punchlist.
 - 6. Signed off Test Reports.
 - 7. As-built markups for Record Drawing conversion. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme:
 - a. Red shall indicate new items, deviations and routing.
 - b. Green shall indicate items removed or deleted.
 - c. Blue shall be used for relevant notes and descriptions.
 - 8. Electrical System and Equipment Warranties.

PART 2 PRODUCTS

2.01 GENERAL

- A. All work, materials, and trades shall follow the latest adopted editions of the National Fire Protection Administration (NFPA) and International Code Council (ICC) standards for building construction and energy use. Refer to Architectural code sheet for additional information. It is

the contractor's responsibility to perform work in conformance with all applicable codes, ordinances, and life safety measures as required, by local, state, and national authorities. Consult literature and websites of jurisdictional authorities for any amendments or additional requirements.

- B. All materials shall be new and listed for the application unless otherwise noted. Equipment shall be set straight and square with the structure. Conduit shall be installed parallel or at right angles to all walls and structural members. Hanger rods, equipment bases, supports and isolation shall be set plumb and square and in vertical alignment where applicable. All work shall be neat and clean upon completion. All work shall be performed in a workmanlike manner to the satisfaction of the architect, owner, and engineer.
- C. NEC and UL: Products shall conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used shall be listed and labeled by UL.
- D. Basis of Design: Items specified herein by manufacturer and model number are to be considered the minimum quality acceptable for the specified application. For substitutions, it shall be the responsibility of the contractor to provide sufficient information to the Design Team in order to establish "or equal" status and to coordinate installation of same into the available space. Increased costs to the project associated with contractor substitutions shall be the responsibility of the contractor.
- E. Substitutions: The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
- F. Owner Furnish Contractor Installed (OFCI): This contractor shall be responsible for the receiving and installation of all Owner supplied equipment unless noted otherwise. This scope requires coordination with the owner supplied equipment, and not all details of that equipment are necessarily included in these drawings. Refer to manufacturer's drawings, equipment submittal data sheets, and equipment manufacturer's selections and refurbishment guidelines for new project altitude, and meet the requirements defined therein.
- G. Owner shall pay all fees required for connection to municipal and public utility facilities through their service contract with each respective service provider.
- H. Contractor shall arrange for and pay for all permits, inspections, licenses and certificates required in connection with the work.
- I. Existing: Equipment and control systems should match, integrate, communicate or cooperate with Owner's existing systems, such as power monitoring systems, building automation, fire alarm, motor control centers, switchgears, breakers, transformers, and lighting dimming systems.

2.02 DELIVERY, STORAGE AND HANDLING

- A. All equipment and materials shall be delivered to the Project Site clean and sealed for protection. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Moisture: During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately upon receiving the products and maintain continually.
- C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- D. Finish: Protect factory finish from damage during construction operations until acceptance of the Project. Restore any finishes that become stained or damaged to Owner's satisfaction.
- E. Check delivered equipment against contract documents and submittals. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
- F. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

2.03 DELEGATED AND/OR DEFERRED DESIGN BY CONTRACTOR

- A. The construction of this project requires the Contractor to include the detailing and design of select systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.
- B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers' contract drawings shall be for system design intent and general configurations.
- C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:
 - 1. Temporary Facilities
 - 2. Utility Company Coordination details
 - 3. Final coordinated pathways for distribution systems within the ceiling cavity
 - 4. Fire alarm shop drawings
 - 5. Equipment supports, hangers, anchors
 - 6. Seismic restraint systems

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Installation shall be in accordance with manufacturer's published recommendations.
- C. Cooperation with Other Trades: Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.
- D. Workmanship: Work shall be performed by competent workers skilled in their trade. This installation must be complete.
- E. Housekeeping Pads: Provide 4.0 inch high concrete housekeeping pad for all floor mounted equipment including, but not limited to: switchgear, switchboards, motor control centers, floor mounted distribution panelboards, floor mounted branch panelboards, and floor mounted dry type transformers. Fabricate pads as follows:
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 3.0 inches larger in both directions than the overall dimensions of the supported unit.
 - 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 - 3. Place concrete and allow proper curing before installation of units. Use Portland cement that conforms to ASTM C 150; 4,500-psi compressive strength with 5% ($\pm 1.5\%$) entrained air, and normal weight aggregate.
 - 4. Anchor housekeeping pads to slab using #5 rebar bent in "L" or "Z" shape 12 inch on center on each side of slab.
- F. Setting of Equipment: Equipment must be leveled and set plumb. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers or by 3.0 inches of air for freestanding units. Use corrosion resistant bolts, nuts and washers to anchor equipment. Provide Drawings and layout Work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases in sufficient time to be coordinated with Work under other divisions.
- G. Sealing of Equipment: Seal openings into equipment to prevent entrance of animals, birds and insects.
- H. Motors: Electrical Work includes the electrical connection of all motors, except those that are wired as a part of equipment.
- I. Concealed Work: Conceal all electrical Work in walls, floors, chases, under floors, underground, and above ceilings except:
 - 1. Where shown or specified to be exposed. Exposed is open to view.
 - 2. Where exposure is necessary to the proper function.
 - 3. Where size of materials and equipment preclude concealment.

- J. Provide final electrical connections to equipment furnished under other divisions and by the Owner. Furnish detailed Shop Drawings of equipment indicating the exact number and location of rough-in points. Such final Shop Drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the Work required.
 - 1. Roughing-in: When roughing-in electrical branch circuits to various items of equipment, terminate at proper points as indicated on detailed equipment Shop Drawings or as directed by Owner. Do not rely on Drawings accompanying these Specifications for rough-in locations, only for general routing of circuiting.
- K. Final Connections: Laboratory casework, medical equipment, and food service equipment will include service fittings such as switches, duplex receptacles, lighting fixtures, etc., on the casework or equipment. Provide branch circuit connections to meet service fitting requirements.
- L. All unused openings such as but not limited to, knockouts on panels and boxes, surface wireway openings, busway openings, circuit breaker empty slots shall be covered with approved cover plates.
- M. Space Limitations: Equipment selected shall conform to the building features and shall be coordinated with all components. Do not provide equipment that will not meet arrangement and space limitations. Contractor shall submit room layouts with submitted items shown drawn to scale. Submittals will be rejected without floor plan Drawings showing submitted items.
- N. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure. Make allowance for expansion and contraction for all building electrical components and conduit systems that are subject to such.
- O. Remote Ballasts: For remote ballasts not within five (5) feet of their associated lighting fixture, provide appropriate permanent lettering on both the ballasts and the light fixture to identify which are mated to the other.
- P. Provide all necessary scaffolding, ladders, hoists, rigging, etc. As required for the installation of the work within the scope of Division 26, 27, and 28. All hoisting, supports, delivery, etc of equipment and material for this project shall be the responsibility of this contractor.
- Q. Extend all conduits so that junction and pull boxes are in accessible locations. Provide access panel or doors where equipment or boxes are concealed behind finished surfaces.
- R. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed contactor/relays, ballast/drivers, motors, fans, and other operating devices requiring adjustment or servicing. Refer to Division 01 for access door specification and requirements.
- S. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only. Furnish doors to trades performing work in which they are to be built, in ample time for building in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space. Access doors in fire rated walls and ceilings shall have equivalent U.L. label and fire rating.

- T. On Site Metering: When called for in the specifications or on the drawings, the Contractor shall meter the points indicated for a period of 30 days prior to start of construction to verify existing load. Meter shall record voltage; amperage; KVA; and Power Factor for each phase and sum of the phases. The meter shall continually average the power demand over maximum 15 minute intervals as required by NEC 220.87. Compile a metering summary report and deliver results to engineer no more than seven days following metering duration. Verify existing loads at and downstream of the metering location and provide list to engineer of what loads are not on during the 30 day metering and the reason why. Organize list by equipment name. If any loads have been removed or permanently abandoned, Turn circuit breaker off and relabel as SPARE.

3.02 TESTING

- A. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract as well as all equipment, wiring, devices, etc being reused within the scope of this project.
- B. Verify operation and functional performance of electrical power delivery systems, lighting system and digital lighting controls for compliance with "Design Intent", as defined by the Contract Documents. Furnish labor and material to accomplish complete mechanical and electrical system commissioning as specified herein. Complete interim commissioning of electrical systems during initial season operation.
- C. Job Conditions: The commissioning contractor shall become familiar with the contract documents all Addenda and change orders issued for this project prior to commencing the commissioning work.
- D. Qualifications: The "Commissioning Authority" shall be defined as a company or agency of experienced personnel, qualified to plan & carry out the overall commissioning progress. The Commissioning Authority shall submit for owner review, an outline of the organization's personnel qualification resources, commissioning, documentation process and commissioning plan specifically prepared for this project.
- E. Contractors Specialty: Individual sub-contractors for the appropriate mechanical and electrical divisions - will be responsible for providing labor, material, equipment, etc., required within the scope of commissioning to facilitate the commissioning process. The listed Sub-Contractor will perform tests and verification procedures required by the commissioning process when requested by the Commissioning Authority and directed by the General Contractor.
- F. Required Testing:
1. Required studies to be performed by the Contractor include:
 - a. Short-Circuit Study
 - b. Coordination Study
 - c. Arc-Flash Hazard Study
 - d. Load Flow Study
 - e. Harmonic-Analysis Study
 2. Required inspections and tests to be performed by the Contractor include:
 - a. Switchgear and Switchboard Assemblies - NETA ATS Section 7.1
 - b. Dry-Type Low Voltage Transformers - NETA ATS Section 7.2.1.1
 - c. Liquid Filled Transformers - NETA ATS Section 7.2.2
 - d. Low Voltage Cables (24V Max) - NETA ATS Section 7.3.1

- e. Low Voltage Cables (600V Max) - NETA ATS Section 7.3.2
 - f. Medium and High Voltage Cables - NETA ATS Section 7.3.3
 - g. Metal Enclosed Busways - NETA ATS Section 7.4
 - h. Low Voltage Switches (Air) - NETA ATS Section 7.5.1.1
 - i. Medium Voltage Switches (Air) - NETA ATS Section 7.5.1.2
 - j. Medium Voltage Switches (Oil) - NETA ATS Section 7.5.2
 - k. Medium Voltage Switches (Vacuum) - NETA ATS Section 7.5.3
 - l. Cut Out Switches - NETA ATS Section 7.5.5
 - m. Insulated Case Circuit Breakers - NETA ATS Section 7.6.1.1
 - n. Low Voltage Circuit Breakers - NETA ATS Section 7.6.1.2
 - o. Protective Relays - NETA ATS Section 7.9.1
 - p. Metering Devices - NETA ATS Section 7.11.2
 - q. Grounding Systems - NETA ATS Section 7.13
 - r. Ground Fault Systems - NETA ATS Section 7.14
 - s. Rotating Machinery - NETA ATS Section 7.15.1/2/3
 - t. Motor Control Low Voltage Starters - NETA ATS Section 7.16.1.1
 - u. Low Voltage Motor Control Center - NETA ATS Section 7.16.2.1
 - v. Adjustable Speed Motor Drives - NETA ATS Section 7.17
 - w. DC System Batteries - NETA ATS Section 7.18.1.1/2/3
 - x. DC System Chargers - NETA ATS Section 7.18.2
 - y. Low Voltage Surge Arrestors - NETA ATS Section 7.19.1
 - z. Emergency Systems Generator - NETA ATS Section 7.22.1
 - aa. Emergency System Transfer Switch - NETA ATS Section 7.22.3
 - bb. Communications Cabling - NETA ATS Section 7.23
 - cc. Fiber Optic Cables - NETA ATS Section 7.25
3. Additional Equipment Requirements:
- a. Where indicated hereinafter in these Specifications, the tests and/or operational check shall be performed by a recognized independent testing agency.
 - b. The testing agency shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the International Electric Testing, Inc. Association constitutes proof of meeting such criteria.
 - c. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:
 - 1) Field Instruments: 6 months maximum
 - 2) Laboratory Instruments: 12 months
 - 3) Leased specialty equipment: 12 months. (Where accuracy is guaranteed by lessor, i.e., Doble).
 - 4) Dated calibration labels shall be visible on all test equipment.
 - d. The testing agency shall be responsible for implementing all final settings and adjustments on protective devices in accordance with Owner's specified values.
 - e. Set transformer taps to obtain the nominal secondary voltage rating on drawings.
- G. Test Conditions:
- 1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's representative(s). Furnish all instruments, wiring,

- equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Contract Documents. Special tests on certain items are specified hereinafter.
2. Testing shall be performed by an independent testing company that is Owner approved, and National Electrical Testing Association (NETA) certified. Submit copies of test reports.
 3. Prior to testing, Contractor shall submit to Owner for approval, installation verification Prefunctional Checklists and Functional Performance Test procedures. These shall be used for documentation as part of the commissioning process.
 4. All instruments required for conducting the tests shall be NIST (National Institute for Standard and Technology) certified or traceable, and calibrated at the time of testing.
- H. Test Dates: Schedule final acceptance sufficiently in advance of the Contract date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract. Provide written notification to Owner at least fourteen (14) calendar days in advance of Functional Performance Test dates.
- I. Retests: If retesting is required due to initial failure, conduct retests of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of Contractor's responsibility under this Contract.
- J. Test Report: Submit three copies of the completed report no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified. The test report shall include the following:
1. Summary of project.
 2. Description of equipment tested.
 3. Description of test.
 4. List of test equipment used in calibration and calibration date.
 5. Test results.
 6. Conclusions and recommendations.
 7. Appendix, including appropriate test forms
- K. Circuit Verification: All 120-volt single-phase circuits shall be verified to match the Drawings and panel schedules by "ringing out" each circuit in the presence of the Owner's representative(s).
- L. Refer to Commissioning Specification Sections for additional start-up, pre-functional and operational checkout, and for functional performance test procedures.
- M. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, settings reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the Architect/Engineer
- 3.03 SUBSTANTIAL COMPLETION and CLOSEOUT
- A. Substantial Completion
 1. See requirements in Section 26 0005
 - B. Closeout Requirements

1. See requirements in Section 26 0005

END OF SECTION

SECTION 26 0505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 3 EXECUTION

1.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Report discrepancies to Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

1.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
- D. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
- E. Existing Communications and Security Systems: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

1.04 CLEANING AND REPAIR

- A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 0519 - ELECTRICAL CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Field Quality Control Test Reports.
- C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits and all panel feeders.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.05 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is permitted only as follows:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
- 2. In addition to other applicable restrictions, may not be used:
 - a. Where exposed to view, except in dedicated electrical, communications, and mechanical rooms where not subject to damage.
 - b. Where exposed to damage.
 - c. For damp, wet, or corrosive locations.
 - d. For isolated ground circuits.
 - e. For patient care areas of health care facilities requiring redundant grounding.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. MC cable for healthcare application shall be listed as HCF.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
- I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- J. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Travelers for 3-Way and 4-Way Switching: Pink.
 - e. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.

- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

2.04 METAL-CLAD CABLE

- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- B. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- E. Grounding: Full-size integral equipment grounding conductor.
- F. Armor: Steel, interlocked tape.

2.05 VARIABLE-FREQUENCY DRIVE CABLE

- A. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
- B. Conductor Stranding: Stranded.
- C. Insulation Voltage Rating: 1000 V.
- D. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.
- E. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
- F. Provide metallic shielding.
- G. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.06 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- C. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
- D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- G. Mechanical Connectors: Provide bolted type or set-screw type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.07 ACCESSORIES

- A. Electrical Tape:
1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Wire Pulling Lubricant:
1. Listed and labeled as complying with UL 267.
 2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 3. Suitable for use at installation temperature.
- D. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. For 20A/1P circuits: Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- H. Terminate cables using suitable fittings.
 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- I. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- M. Make wiring connections using specified wiring connectors.
 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

- R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Shop Drawings:
 - 1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
- C. Field quality control test reports.
- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding Electrode System: Existing

1. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
2. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

E. Service-Supplied System Grounding: Existing

F. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

G. Communications Systems Grounding and Bonding: Existing

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.

- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- E. Grounding electrode resistance testing shall be accomplished with a clamp-on ground resistance test meter. Test at all affected points covered under NETA standards. Perform test following final termination of all grounding and bonding connections associated with scope of project. IEEE Fall of Potential Method may also be used to calculate ground resistance with a direct read meter and two reference probes.

END OF SECTION

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 Administrative Requirements

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
2. Coordinate work to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 3000.

1.02 Submittals

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports.

PART 2 PRODUCTS

2.01 Support and Attachment Components

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2.0. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 2. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 2. Powder-actuated fasteners are not permitted.

PART 3 EXECUTION

3.01 Installation

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners in accordance with manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.02 Field Quality Control

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

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SECTION 26 0533 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
4. Where aluminum rigid metal conduit (RMC) and aluminum electrical metallic tubing (EMT) is installed in concrete, use corrosion protection tape, factory-applied corrosion

protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.

- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- E. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC).
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- J. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use liquidtight flexible metal conduit (LFMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
 - 3. Maximum Length: 6 feet unless otherwise indicated.
- K. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC) or galvanized steel electrical metallic tubing (EMT).

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4-inch trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch trade size.
 - 3. Control Circuits: 1/2-inch trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.06 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.
 - 4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.07 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
 - 2. Material: Use aluminum.

3. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.
4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.08 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- B. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- C. Sealing Systems for Concrete Penetrations:
 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
- D. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
- F. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. Conceal conduits unless specifically indicated to be exposed.
 3. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 4. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.

5. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 6. Arrange conduit to maintain adequate headroom, clearances, and access.
 7. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 8. Arrange conduit to provide no more than 150 feet between pull points.
 9. Route conduits above water and drain piping where possible.
 10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 13. Group parallel conduits in same area on common rack.
- E. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 0529.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 6. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 7. Use of wire for support of conduits is not permitted.
- F. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- G. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 8400.
- H. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- I. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- J. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- K. Provide grounding and bonding; see Section 26 0526.
- L. Identify conduits; see Section 26 0553.
- 3.02 FIELD QUALITY CONTROL
- A. See Section 01 4000 - Quality Requirements for additional requirements.
 - B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
 - C. Correct deficiencies and replace damaged or defective conduits.

3.03 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

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SECTION 26 0534 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
 - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
 - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
 - 6. Coordinate the work with other trades to preserve insulation integrity.
 - 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
 - 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures and floor boxes.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
12. Wall Plates: Comply with Section 26 2726.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 - 2. Locate boxes as required for devices installed under other sections or by others.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - 9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.
- H. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 26 0526.
- Q. Identify boxes in accordance with Section 26 0553.
- 3.02 CLEANING
- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.
- 3.03 PROTECTION
- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.03 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) See electrical plans for tag requirements and details.
 - 2) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - b. Enclosed switches and motor controllers:
 - 1) See electrical plans for tag requirements and details
 - c. Time Switches:

- 1) Identify load(s) served and associated circuits controlled. Include location.
 - d. Enclosed Contactors:
 - 1) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 2) Identify load(s) and associated circuits controlled. Include location.
 2. Emergency System Equipment:
 - a. See electrical plans for tag requirements and details.
 - b. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - c. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 3. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 4. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
 5. Available Fault Current Documentation: Use identification nameplate to identify the available fault current and date calculations were performed at locations indicated.
 6. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
- C. Identification for Conductors and Cables:
1. Identification for Communications Conductors and Cables: Comply with Section 27 1000.
 2. Use identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment.
- D. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 2. Use color-coded bands or factory-painted conduits to identify specified systems for accessible conduits.
 - a. Maximum Intervals: 20 feet.
 - b. Color-Coded Bands: Use vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
 - c. UW Color Code:
 - 1) Normal Power System: Unpainted.
 - 2) Emergency Power System: Orange.
 - 3) Fire Alarm System: Red.
 - 4) BMS/Temp Control System: Dark Blue.

- 5) Data & Telephone System: Light Blue.
 - 6) Security System: Yellow.
 - 3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 - E. Identification for Boxes:
 - 1. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
 - b. For exposed boxes in public areas, do not color code.
 - 2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
 - F. Identification for Devices:
 - 1. Identification for Communications Devices: Comply with Section 27 1000.
 - 2. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 - G. Identification for Luminaires:
 - 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.
- 2.02 IDENTIFICATION NAMEPLATES AND LABELS
- A. Identification Nameplates:
 - 1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use stainless steel or aluminum nameplates suitable for exterior use.
 - 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - 3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
 - B. Identification Labels:
 - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
 - C. Format for Equipment Identification:
 - 1. See electrical plans for tag requirements and details.

2. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System:
 - 1) Life Safety Branch: Black text on Yellow background.
 - 2) Critical Branch: Black text on Orange background.
 - 3) Equipment Branch: White text on Blue background.
 - c. Fire Alarm System: Red text on White background.

2.03 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
 1. Markers for Voltage Identification: Highest voltage present.
 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- E. Color: Black text on orange background unless otherwise indicated.

2.04 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 1. Materials:
 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Interior Components: Legible from the point of access.
 - 6. Conduits: Legible from the floor.
 - 7. Boxes: Outside face of cover.
 - 8. Conductors and Cables: Legible from the point of access.
 - 9. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION

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SECTION 26 0573 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
 - 2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Study reports, stamped or sealed and signed by study preparer.
- C. Site-specific arc flash hazard warning labels.
- D. Field quality control reports.
- E. Project Record Documents: Revise studies as required to reflect as-built conditions.
 - 1. Include hard copies with operation and maintenance data submittals.
 - 2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.04 POWER SYSTEM STUDIES

- A. Scope of Studies:
 - 1. Perform analysis of new electrical distribution system as indicated on drawings.
 - 2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).

3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
- B. General Study Requirements:
 1. Comply with NFPA 70.
 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
 1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
 - c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - e. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
- D. Short-Circuit Study:
 1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
- E. Protective Device Coordination Study:
 1. Comply with applicable portions of IEEE 242 and IEEE 399.

2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.
- F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
 2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
 3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
- G. Study Reports:
1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
 2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.
 - 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
 3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.

- 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
 - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
 - d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
- 4. Arc Flash and Shock Risk Assessment:
 - a. For the worst case for each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.05 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.
- B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
 - 1. Materials: Comply with Section 26 0553.
 - 2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Nominal system voltage.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Adjust equipment and protective devices for compliance with studies and recommended settings.
- D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

END OF SECTION

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SECTION 26 0583 - WIRING CONNECTIONS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 26 2816 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 2726.

PART 3 EXECUTION

3.01 ELECTRICAL CONNECTIONS

- A. Division of responsibility is suggested below. However, all works remains a responsibility of the Prime Contract holder.
1. Legend is understood as follows:
 - a. GC - General Contractor
 - b. MC - Mechanical and/or Plumbing Contractor
 - c. EC - Electrical Contractor
 - d. F - Furnished: Procure Equipment and/or Materials
 - e. I - Installed: Set in Place, Equipment and/or Materials
 - f. W - Wired: Land conductors on manufacture's dicated terminals
 - g. CPW - Control Power and Wiring
 - h. INT - Integration: Programming, Testing, and/or Certificaiton
 2. Equipment motors
 - a. F=MC, I=MC, W=EC
 3. Magnetic motor starters
 - a. Auto Control w/ or w/o HOA
 - 1) F=MC, I=EC, W=EC, CPW=MC
 - b. Auto Control w/ or w/o HOA but supplied as a part of factory-wired equipment
 - 1) F=MC, I=MC, W=MC, CPW=MC
 - c. Manually controlled
 - 1) F=MC, I=MC, W=EC, CPW=MC
 - d. Manually controlled but supplied as a part of factory-wired equipment
 - 1) F=MC, I=MC, W=MC, CPW=MC
 4. Push-button stations/ pilot lights
 - a. Full loads amps
 - 1) F=MC, I=EC, W=EC, CPW=EC
 - b. Non-Full load amps
 - 1) F=MC, I=MC, W=MC, CPW=MC
 5. Disconnect switches/ thermal overload switches
 - a. F=EC, I=EC, W=EC
 6. Multi-speed/ manual switches
 - a. F=MC, I=EC, W=EC, CPW=EC
 7. Temperature control relays / transformers
 - a. Control relay and control transformers shall be furnished under the mechanical contract except where furnishing such items is specifically required under the electrical specifications and/or drawings.
 - b. F=MC, I=MC, W=EC, CPW=EC
 8. Electric thermostats at time clock
 - a. Immersion thermostats, remote bulb thermostats, motor valves, floor controls, etc. that are an integral part of the mechanical equipment or directly attached to ducts, piping, equipment, etc. shall be set in place under mechanical contract. Motor driven units which are controlled from line voltage manual operating or start-stop switches or 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. This description shall apply to units not integrated into a centralized temperature control programming system, and in general applies to 120 volts and above control. 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 V, 3 , 3 wire motor requires 120 volt control. Electrical contractor shall furnish a 120 volt circuit for control and 208 volt circuit for power. Mechanical contractor shall wire all controls).

- b. Full loads amps
 - 1) F=MC, I=EC, W=EC, CPW=EC
 - c. Non-Full load amps
 - 1) F=MC, I=MC, W=MC, CPW=MC
9. Remote bulb thermostats/ motor valves/ etc. integral to mechanical equipment or directly attached to ducts/ pipes/ etc.
- a. Immersion thermostats, remote bulb thermostats, motor valves, floor controls, etc. that are an integral part of the mechanical equipment or directly attached to ducts, piping, equipment, etc. shall be set in place under mechanical contract. Motor driven units which are controlled from line voltage manual operating or start-stop switches or 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. This description shall apply to units not integrated into a centralized temperature control programming system, and in general applies to 120 volts and above control. 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 V, 3 , 3 wire motor requires 120 volt control. Electrical contractor shall furnish a 120 volt circuit for control and 208 volt circuit for power. Mechanical contractor shall wire all controls).
 - b. F=MC, I=MC, W=EC, CPW=EC
10. Temperature control panels and time clocks mounted on panels
- a. F=MC, I=MC, W=EC, CPW=MC
11. Motors/ Valves/ Damper motor
- a. F=MC, I=MC, W=EC, CPW=MC
12. Control circuit outlet
- a. F=EC, I=EC, W=EC
13. Fire protection control
- a. F=MC, I=MC, W=EC, CPW=EC
14. Smoke detectors and relays for fan shutdown
- a. Building w/ fire alarm system
 - 1) F=EC, I=EC, W=EC, CPW=EC
 - b. Building w/o fire alarm system
 - 1) F=MC, I=MC, W=MC, CPW=MC
15. Smoke dampers and relays for damper closure
- a. F=MC, I=MC, W=EC, CPW=EC
16. Boiler and water heater controls/boiler burner control panels
- a. F=MC, I=MC, W=EC, CPW=MC
17. Temporary heating connections
- a. F=MC, I=MC, W=EC, CPW=EC
18. Low voltage control wire from DDC panel to control device
- a. F=MC, I=MC, W=MC, CPW=MC

- 19. Power wiring for DDC device (valves, damper motors, air valves, VAV boxes, actuators, etc.
 - a. F=MC, I=MC, W=EC
- B. Make electrical connections in accordance with equipment manufacturer's instructions.
- C. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- D. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- E. Provide receptacle outlet to accommodate connection with attachment plug.
- F. Provide cord and cap where field-supplied attachment plug is required.
- G. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- H. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- I. Install terminal block jumpers to complete equipment wiring requirements.
- J. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings:
 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
- D. Field Quality Control Reports.
- E. Operation and Maintenance Data: Include detailed information on device programming and setup.
- F. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.04 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.05 FIELD CONDITIONS

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all occupancy sensors.
- C. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 OCCUPANCY SENSORS

- A. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
 - 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 - 6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
 - 7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 - 8. Sensitivity: Field adjustable.
 - 9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.

10. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
 11. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
 12. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.
- B. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - c. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
 - d. Provide vandal resistant lenses for passive infrared (PIR) and dual technology wall switch occupancy sensors.
- C. Wall Dimmer Occupancy Sensors:
1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
 - b. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
 - c. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
- D. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Finish: White unless otherwise indicated.
- E. Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
 2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 3. Input Supply Voltage: Dual rated for 120/277 V ac.

2.03 LIGHTING CONTACTORS

- A. Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.
- B. Short Circuit Current Rating:
 - 1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- C. Enclosures:
 - 1. Comply with NEMA IA 10030.
 - 2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0534 as required for installation of lighting control devices provided under this section.
 - 1. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 2726.
- G. Provide required supports in accordance with Section 26 0529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.03 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

3.04 COMMISSIONING

- A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.
- B. Verify and document that the selected building systems have been designed, installed, and function according to the owner's project requirements and construction documents, and to minimum adopted IECC code requirements for energy conservation.
- C. A commissioning plan shall be developed by a registered design professional or approved agency and shall include the following items:
 - 1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
 - 2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed..
 - 3. Functions to be tested along with baseline descriptors.
 - 4. Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.
 - 5. Measurable criteria for performance.
- D. The final inspection shall include verification of the installation and proper operation of all required building controls, and documentation verifying activities associated with required building commissioning have been conducted and findings of noncompliance corrected. Buildings, or portions thereof, shall not be considered for a final inspection until the code official has received a letter of transmittal from the building owner acknowledging that the building owner has received the Preliminary Commissioning Report as required in Section IECC - C408.2.4.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 2416 - PANELBOARDS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- D. Field Quality Control Test Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Provide panelboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 7,200 feet
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:

- a. Indoor Clean, Dry Locations: Type 1.
2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs or oversized lugs are provided.
3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- J. Load centers are not acceptable.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 3. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

- b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
- 8. Do not use tandem circuit breakers.
- 9. Do not use handle ties in lieu of multi-pole circuit breakers.
- 10. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install panelboards plumb.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 26 0526.
- I. Install all field-installed branch devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.
- L. Provide filler plates to cover unused spaces in panelboards.
- M. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- N. Identify panelboards in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 150 amperes. Tests listed as optional are not required.
- D. Test GFCI circuit breakers to verify proper operation.
- E. Test shunt trips to verify proper operation.
- F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.04 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 2726 - WIRING DEVICES

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
 - 1. Wall Dimmers: Include derating information for ganged multiple devices.
- C. Project Record Documents: Record actual installed locations of wiring devices.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- C. Provide GFCI protection for receptacles installed within 6 feet of sinks.

- D. Provide GFCI protection at breakers for receptacles serving electric drinking fountains.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.
- C. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.03 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 WALL DIMMERS

- A. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- B. Control: Slide control type with separate on/off switch.
- C. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
- D. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.05 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

2. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
- C. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 5. Tamper Resistant and Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
- D. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
- 2.06 Wall Plates and Covers
- A. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0534 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 3. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 - 4. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- M. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

- O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- Q. Identify wiring devices in accordance with Section 26 0553.

3.02 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.03 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

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SECTION 26 2813 - FUSES

PART 1 GENERAL

1.01 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.

1.02 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Equipment Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- B. General Purpose Branch Circuits: Class RK1, time-delay.
- C. Individual Motor Branch Circuits: Class RK1, time-delay.
- D. Primary Protection for Control Transformers: Class CC, time-delay.

2.02 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.

- H. Class CC Fuses: Comply with UL 248-4.
- I. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 2816 - ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- D. Field Quality Control Test Reports.
- E. Project Record Documents: Record actual locations of enclosed switches.

1.02 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.03 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Provide enclosed switches and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 7,200 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
 - 1. Comply with NEMA BS 31047.
 - 2. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.

- H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 2813 - Fuses: Fuses for fusible switches.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
 - 3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 - 4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 6. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Field Quality Control Test Reports.

- F. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
 - 1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.05 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 ENCLOSED CONTROLLERS

- A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
 - a. Altitude: Less than 7,200 feet..
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
- E. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Enclosures:
 - 1. Comply with NEMA IA 10030.
 - 2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 - 3. Finish: Manufacturer's standard unless otherwise indicated.

- H. Instrument Transformers:
 - 1. Comply with IEEE C57.13.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- I. General Purpose Contactors: Combination type unless otherwise indicated.
 - 1. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactor(s) and externally operable disconnect, but without integral overload relay(s).
 - 2. Configuration: Full-voltage non-reversing unless otherwise indicated.
 - 3. Minimum Contactor Size: NEMA Size 0.
 - 4. Disconnects: Circuit breaker or disconnect switch type as indicated.
 - a. Circuit Breakers: Thermal magnetic unless otherwise indicated or required.
 - b. Disconnect Switches: Fusible type unless otherwise indicated.
 - c. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - d. Provide auxiliary interlock for disconnection of external control power sources where applicable.
- J. Manual Motor Starters:
 - 1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
 - 2. Configuration: Non-reversing unless otherwise indicated.
 - 3. Fractional-Horsepower Manual Motor Starters:
 - a. Furnish with toggle operator.
 - b. Overload Relays: Bimetallic or melting alloy thermal type.
 - c. Furnish Red ON indicating light where not within sight of equipment.
 - 4. Integral-Horsepower Manual Motor Starters:
 - a. Furnish with toggle or pushbutton operator.
 - b. Overload Relays: Bimetallic or melting alloy thermal type.
 - c. Furnish Red ON indicating light where not within sight of equipment.

2.02 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 3. Trip-free operation.
 - 4. Visible trip indication.
 - 5. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 - 6. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.

- b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
- 7. Solid-State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

B. Fusible Disconnect Switches:

- 1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
- 2. Fuse Clips: As required to accept indicated fuses.
- 3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

C. Circuit Breakers:

- 1. Interrupting Capacity (not applicable to motor circuit protectors):
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- 2. Motor Circuit Protectors:
 - a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
 - b. Provide field-adjustable magnetic instantaneous trip setting.

2.03 CONTROL ACCESSORIES

A. Auxiliary Contacts:

- 1. Comply with NEMA IA 10039.
- 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:

- 1. Comply with NEMA IA 10039; heavy-duty type.
- 2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.

3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
 4. Indicating Lights: Push-to-test type unless otherwise indicated.
 5. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
1. Comply with NEMA IA 10039.
 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:
1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices.
 2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Install enclosed controllers plumb and level.
- E. Install all field-installed devices, components, and accessories.
- F. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
- G. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- H. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
- D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1. Tests listed as optional are not required.
- F. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

END OF SECTION

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.

D. Field quality control reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.

- 3. Extra Lamps / LED Boards: Ten percent of total quantity installed for each type, but not less than two of each type.
- 4. Extra Ballasts / Drivers: Two percent of total quantity installed for each type, but not less than one of each type.
- G. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.03 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.04 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for LED luminaires, including drivers.
- C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- H. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
 - 1. Self-Powered Exit Signs:
 - a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
 - b. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 - c. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- B. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.05 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.02 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0534 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 4. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
- H. Suspended Luminaires:
 - 1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.

- K. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- L. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- M. Install lamps in each luminaire.
- N. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs and battery-backed drivers to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.04 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.05 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

END OF SECTION

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SECTION 27 0533 - CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of cables to be installed.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of communications cables until installation of conduit between termination points is complete.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, TIA-569, BICSI ITSIMM, BICSI TDMM, manufacturers' instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
 - 2. Within Slab Above Ground: Not permitted.
 - 3. Within Concrete Walls Above Ground: Use PVC-coated galvanized steel rigid metal conduit (RMC) or rigid PVC conduit.
 - 4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to stainless steel intermediate metal conduit (IMC) where emerging from concrete.

- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- E. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70 and TIA-569.
- B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
 - 4. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- C. PVC-Coated Boxes and Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
 - 5. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.05 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
 - 5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.06 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
 - 2. Material: Use aluminum.
 - 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
 - 5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.

- a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.07 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage.
- B. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
 - 3. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.08 INSIDE-PLANT FLEXIBLE NONMETALLIC COMMUNICATIONS RACEWAY/INNERDUCT

- A. Description: Flexible, corrugated, nonmetallic communications raceway and associated fittings listed and labeled as complying with UL 2024; also suitable for installation as innerduct.
- B. Raceway Applications: Use listed plenum raceway unless otherwise indicated.
- C. Use only with approved cables in accordance with listing.

2.09 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- D. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- E. Install galvanized steel electrical metallic tubing (EMT) in accordance with NECA 101.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. Conceal conduits unless specifically indicated to be exposed.
 - 3. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 4. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 5. Arrange conduit to provide no more than equivalent of two 90-degree bend(s) between pull points.
 - a. The equivalent of three 90-degree bends between pull points is permitted only under conditions described in BICSI TDMM.
 - 6. Arrange conduit to provide no more than 100 feet between pull points.
 - 7. Arrange conduit to provide minimum bend radii in accordance with BICSI TDMM.
 - 8. Route conduits above water and drain piping where possible.
 - 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 10. Maintain recommended separation from sources of EMI greater than 5 kVA in accordance with BICSI ITSIMM and BICSI TDMM.
 - 11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - 13. Group parallel conduits in same area on common rack.
- H. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 - 5. Use metal channel/strut with accessory conduit clamps to support multiple, parallel, surface-mounted conduits.
 - 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 - 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple, parallel, suspended conduits.
 - 8. Use of spring steel conduit clips for support of conduits is not permitted.
 - 9. Use of wire for support of conduits is not permitted.
- I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
5. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
6. Secure joints and connections to provide mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
4. Conceal bends for conduit risers emerging above ground.
5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Provide metal escutcheon plates for conduit penetrations exposed to public view.
9. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 8400.

K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

L. Provide pull string in each empty conduit and innerduct/cell, and in each conduit where cables are to be installed by others. Leave minimum slack of 12 inches at each end.

M. Provide grounding and bonding.

N. Identify conduits.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.03 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.04 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of cables.

END OF SECTION

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SECTION 27 1000 - STRUCTURED CABLING

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Arrange for Communications Service Provider to provide service.
- C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on drawings.
- H. Extra Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Patch Panels: One (1) of each different type.
 - 2. Patch Cords: Ten (10) of each different type.
 - 3. Connecting Blocks: One (1) of each different type.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.
- C. Submit manufacturer warranty and ensure that forms have been completed in owner's name and registered with manufacturer. The statement of warrantee shall be provided on manufacturer's letterhead. Products shall carry a limited lifetime warranty from physical product defects. Provide paperwork for both the Limited Lifetime Warranty

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 - 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 - 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. System Description:
 - 1. Building Entrance Cable: Existing.
 - 2. Backbones - Within Building: Fiber Optic, See Riser.
- C. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

- D. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS

- A. Conduit: See section 27 0533.
- B. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

2.03 COPPER CABLE AND TERMINATIONS

- A. Copper Backbone Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
 - 2. Cable Type: TIA-568.2 Category 3 UTP (unshielded twisted pair); 24 AWG.
 - 3. Cable Capacity: Quantity of pairs as indicated on drawings.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
- B. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
 - 5. Cable Jacket Colors: _____.
 - a. Fire and Smoke: Red Cable.
 - b. Data & VoIP Tele: Blue Cable.
 - c. Building Controls (BAS/BMS): Black Cable.
 - d. Video Surveillance: Yellow Cable.
 - e. Electronic Access Control: Yellow Cable.
 - f. Wireless Access Points: Green Cable.
 - g. Light Controls: Green Cable.
- C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.

- E. Copper Patch Cords:
 - 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.

2.04 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Backbone Cable:
 - 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 - 2. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC.
 - 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 - 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
 - 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.
- B. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type LC.
 - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
- C. Fiber Optic Patch Cords:
 - 1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
 - 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: five (5) feet.

2.05 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Copper Cross-Connection Equipment:
 - 1. Connector Blocks for Category 3 Cabling: Type 66 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
 - 2. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
 - 3. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - d. Provide incoming cable strain relief and routing guides on back of panel.

- B. Fiber Optic Cross-Connection Equipment:
 - 1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.
 - d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.

- C. Equipment Frames, Racks and Cabinets:
 - 1. Component Racks: EIA/ECA-310 standard 19 inch wide.

2.06 COMMUNICATIONS OUTLETS

- A. Outlet Boxes: Comply with Section 26 0534.
 - 1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 - 2. Minimum Size, Unless Otherwise Indicated:
 - a. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
 - b. Fiber Optic Outlets: 4-11/16 inch square by 2-1/8 inch deep (119 by 54 mm) trade size.
- B. Wall Plates:
 - 1. Comply with system design standards and UL 514C.
 - 2. Accepts modular jacks/inserts.
 - 3. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 2726.

2.07 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 26 0526.

2.08 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 26 0553.

2.09 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.02 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Optical Fiber: 39 inches.
- C. Copper Cabling:
 - 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
- D. Fiber Optic Cabling:
 - 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.

- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 3 Backbone: Perform attenuation test.
 - 5. Category 3 Links: Test each pair for short circuit continuity, short to ground, crosses, reversed polarity, operational and ring-back, and dial tone.
 - 6. Category 5e and Above Backbone: Perform near end cross talk (NEXT) and attenuation tests.
 - 7. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- E. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
 - 3. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
- F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

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SECTION 28 4600 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Evidence of designer qualifications.
- C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 - 10. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 - 11. Certification by Contractor that the system design complies with Contract Documents.
 - 12. Do not show existing components to be removed.
- D. Evidence of installer qualifications.
- E. Evidence of instructor qualifications; training lesson plan outline.
- F. Evidence of maintenance contractor qualifications, if different from installer.

- G. Inspection and Test Reports:
 - 1. Submit inspection and test plan prior to closeout demonstration.
 - 2. Submit documentation of satisfactory inspections and tests.
 - 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- H. Operating and Maintenance Data: Revise and resubmit until acceptable; have one set available during closeout demonstration:
 - 1. Complete set of specified design documents, as approved by authority having jurisdiction.
 - 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 - 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 - 4. List of recommended spare parts, tools, and instruments for testing.
 - 5. Replacement parts list with current prices, and source of supply.
 - 6. Detailed troubleshooting guide and large scale input/output matrix.
 - 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 - 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- I. Project Record Documents: Have one set available during closeout demonstration:
 - 1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 - 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 - 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- J. Closeout Documents:
 - 1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 - 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
- K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
 - 1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.

1.03 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 - 1. Provide control units made by the same manufacturer.
- B. Substitutions: See Section 01 6000 - Product Requirements.
 - 1. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide modifications and extensions to the existing automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. Contract Documents (drawings and specifications).
 - d. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 - 5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.

6. Fire Alarm Control Unit: Existing, located at supervising station.
 - B. Supervising Stations and Fire Department Connections:
 1. Public Fire Department Notification: By remote supervising station.
 2. Remote Supervising Station: UL-listed central station under contract to facility.
 3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
 - C. Circuits:
 1. Initiating Device Circuits (IDC): Class B.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B.
 3. Notification Appliance Circuits (NAC): Class B.
 - D. Spare Capacity:
 1. Initiating Device Circuits: Minimum 10 percent spare capacity.
 2. Notification Appliance Circuits: Minimum 10 percent spare capacity.
 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
 - E. Power Sources:
 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - a. The system shall include an integral, transient voltage surge suppression device (SPD) on the incoming 120- volt power. SPD device shall be UL 1449 rated for 380 volts/Type B.
 2. Secondary: Primary power source operating in emergency or standby mode.
 - a. Emergency Battery Power Only: Sized for a period of 4 hours with 15 minutes of alarm operation at the end of this period.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 4. Each Computer System: Provide uninterruptible power supply (UPS).
- 2.03 EXISTING COMPONENTS
- A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
 - B. Clearly label components that are "Not In Service."
 - C. Remove unused existing components and materials from site and dispose of properly.
- 2.04 FIRE SAFETY SYSTEMS INTERFACES
- A. Supervision: Provide new supervisory signals in accordance with NFPA 72 for the following:
 1. Elevator shut-down control circuits.
 2. Existing supervision is understood to comply with Jurisdictional Requirements.
 3. Circuit Integrity
 - B. Alarm: Provide new alarm initiation in accordance with NFPA 72 for the following:

1. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
 2. Duct smoke detectors.
- C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E. Doors:
1. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 7100.

2.05 COMPONENTS

- A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Master Control Unit: Existing.
1. Tones / Notification / Messaging:
 - a. Temporal 3 (3000Hz) for Fire Alarm.
 - b. Temporal 4 (4000Hz) for Carbon Monoxide.
- D. Remote Annunciator: Where shown on the plans, provide an LCD annunciator. Annunciator shall include two lines of 40 character LCD display, alarm silence, system reset, programmable control switches, and be supervised from the FACP panel. Annunciator shall indicate each alarm initiating device or zone by address and description. Alarm conditions shall be indicated for each addressable alarm initiating device.
- E. Addressable Modules:
1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
 2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
 3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
 4. Control Modules: Provide as indicated or as required for selective control of notification appliances.

5. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
- F. Initiating Devices:
1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
 2. Manual Pull Stations: Pull stations shall contain electronics that communicate the station's status to the control panel over the wires which also provide power to the pull station. The address will be set on the station. They will be manufactured from high impact red Lexan. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations will be double action. The front of the station is to be hinged to a back-plate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. The addressable manual station shall be Underwriters' Laboratories Inc. listed for operation with the control panel.
 3. Addressable Detector Bases: All addressable smoke and heat detector heads will plug into their bases. The base will contain electronics that communicate the detector status (normal, alarm, trouble) to the control panel over two wires. The same two wires shall also provide power to the base and detector. Detector heads (smoke or heat) must be interchangeable. Upon removal of the head, a trouble signal will be transmitted to the control panel.
 4. Smoke Detectors: Photoelectric type detectors shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry. The detector shall fit into an addressable base that is common with both the heat and photoelectric type detectors.
 5. Heat Detectors: Thermal detector heads must be UL listed. They will be a combination rate-of-rise and fixed temperature (135 degrees F) type, automatically restorable unless fixed temperature (190 degrees F.) type are specifically required. The detector shall fit into an addressable base that is common with both the photoelectric and ionization type detectors. Provide addressable module for automatic restoring detectors that are not addressable.
- G. Notification Appliances:
1. Combination Horn / Strobe: Provide high impact resistant LEXAN horn/strobe combination devices as shown on the plans. Each assembly shall consist of two independent devices which are manufactured as compatible with each other and with the control equipment. Each assembly shall provide a terminal strip or wire leads for true in-out wiring connections. The strobe unit shall have a candela-second rating in compliance with ADA requirements and be rated at 24 VDC. Notification devices shall be white with red letters "FIRE" on two sides.
 2. Strobes: Provide high impact resistant LEXAN strobe devices as shown on the plans. Each assembly shall be manufactured as compatible with the control equipment. Each assembly shall provide a terminal strip or wire leads for true in-out wiring connections. The strobe unit shall have a candela-second rating in compliance with ADA

requirements and be rated at 24 VDC. Notification devices shall be white with red letters "FIRE" on two sides.

- H. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- I. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
- J. Locks and Keys: Deliver keys to Owner.
- K. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.
 - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 - 4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Notification devices have been located on the drawings. It is the Contractor's responsibility to provide adequate coverage to achieve the required 15 dBA above ambient at all locations throughout the building. If locations shown are inadequate, show additional notification on shop drawing submittal. Additional notification will be added at no additional cost to the contract including conduit wiring, power supplies, etc. .
- C. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- D. Obtain Owner's approval of locations of devices, before installation.
- E. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.

- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 Owner PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.

4. All aspects of operation have been demonstrated to Owner.
5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- C. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- D. Comply with Owner's requirements for access to facility and security.

END OF SECTION

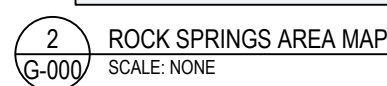
1200 COLLEGE DRIVE
ROCK SPRINGS, WY 82901



1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

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SHEET NO. **G000**



MECHANICAL ELECTRICAL PLUMBING ENGINEER:
SPACEK TIMBIE AND BLEVINS ENGINEERING, INC
523 PARK POINT DR. SUITE 320
GOLDEN, CO 80401
307.900.8782

LAUNDRY RENOVATION & CLEAN LINEN RELOCATION
MEMORIAL HOSPITAL OF SWEETWATER COUNTY (MHSC) - ROCK SPRINGS, WY

PURPOSE - TO ADDRESS AGING LAUNDRY EQUIPMENT, IMPROVE AIRFLOW, ENVIRONMENTAL CONTROL AND EQUIPMENT RELIABILITY IN THE LAUNDRY PROCESSING AREA, AND ESTABLISH A DEDICATED CLEAN LINEN STORAGE SPACE OUTSIDE THE ACTIVE LAUNDRY WORKFLOW.

PROJECT GOALS -

1. CREATE A NEW DEDICATED CLEAN LINEN STORAGE ROOM IN A PORTION OF FORMER HEALTH RECORDS SPACE ACROSS THE CORRIDOR, ELIMINATING STORAGE OF CLEAN LINEN IN LAUNDRY PROCESSING AREA.
2. PROVIDE ALL LAUNDRY EQUIPMENT AT OR BEYOND END OF SERVICE LIFE, INCLUDING WASHEXTRACTORS, DRYERS, AND IRONER.
3. IMPROVE VENTILATION AND LAUNDRY PROCESSING ENVIRONMENTAL STABILITY BY ENCLOSING NEW DRYERS AND SUPPLYING THEM DIRECTLY WITH OUTDOOR AIR PLENUM.
4. ADD DIRECTED COOLING SYSTEM FOR LAUNDRY TO REDUCE EXISTING LOAD ON CENTRAL STATIONARY AIR SERVING THE AREA.
5. PROVIDE A NEW DEDICATED LAUNDRY SERVICE PLUMBING SERVING LAUNDRY TO INCREASE OPERATIONAL RELIABILITY.
6. REPLACE ABOVE GRADE SANITARY DRAINAGE SYSTEMS IN THE RENOVATION AREA AND REHABILITATE (LINE) BELOW GRADE SANITARY DRAINAGE SYSTEMS SERVING THE AREA.

EXISTING CONDITIONS

THE EXISTING LAUNDRY INCLUDES TWO WASHER/EXTRACTORS, THREE STEAM-HEATED TUMBLE DRYERS, AND A STEAM-HEATED IRONER. DRYER DISCHARGE CONNECTS TO AN OVERHEAD INLINE FILTER AND BLOWER ASSEMBLY. DRYERS CURRENTLY DRAW REPLACEMENT AIR DIRECTLY FROM CONDITIONED ROOM AIR, INCREASING HVAC LOADS.

THE DRYER/IRONER AREA IS ALSO USED FOR CLEAN LINEN STORAGE, CAUSING UNDESIRABLE CO-LOCATION OF CLEAN MATERIALS WITH LINT-PRODUCING PROCESSES. VENTILATION, INCLUDING DRYER MAKEUP AIR, IS SUPPLIED FROM CENTRAL STATION AIR HANDLING UNITS.

THE EQUIPMENT IS AT OR BEYOND ITS USEFUL SERVICE LIFE, RESULTING IN DECREASED RELIABILITY AND EFFICIENCY

PROJECT SCOPE

- 1- CLEAN LINEN STORAGE RELOCATION - A PORTION OF FORMER HEALTH RECORDS ROOM ACROSS THE CORRIDOR WILL BE RELOCATED INTO A NEW CLEAN LINEN STORAGE ROOM. THIS SPACE WILL RECEIVE A DEDICATED HVAC CONTROL ZONE AND BE BALANCED TO MAINTAIN OUTWARD (POSITIVE) AIRFLOW RELATIVE TO ADJACENT AREAS. ALL CLEAN LINEN WILL BE PERMANENTLY RELOCATED TO THIS ROOM.
- 2- LAUNDRY EQUIPMENT REPLACEMENT AND HVAC - WASHER/EXTRACTORS AND THE IRONER WILL BE REPLACED IN KIND. TUMBLE DRYERS WILL BE REPLACED AND RELOCATED WITHIN THE LAUNDRY TO A NEW ARRANGEMENT AND PLACED INSIDE A NEW DRYER ENCLOSURE. BECAUSE OUTDOOR-AIR DRYER INTAKE REQUIRES MAINTAIN AIR DEMAND ON THE CENTRAL STATION AHU, THE LAUNDRY ROOM WILL RECEIVE A NEW RECURRICULATING CHILL- WATER FAN COIL TO MAINTAIN THERMAL COMFORT.

- 3-ELECTRICAL - ESTABLISH NEW EQUIPMENT BRANCH PANELBOARD TO SERVE LAUNDRY TO ALLOW CONTINUED OPERATION DURING NORMAL POWER OUTAGE.

- 4-SANITARY SEWER - REPLACE ALL OVERHEAD PIPING AND REHABILITATION ALL BELOW GRADE PIPING DURING RENOVATION

OPERATIONAL AND WORKFLOW CHANGES -

THE NEW PROGRAM ESTABLISHES SEPARATE CLEAN LINEN STORAGE SPACE. STORAGE OF CLEAN LINENS POST PROCESSING IN THE LAUNDRY SPACE WILL REQUIRE CART TRANSPORT ACROSS ADJACENT CORRIDOR TO THE NEW CLEAN LINEN STORAGE SPACE

NEW LOCATION OF DRYERS WILL ALTER WORKFLOW WITHIN THE CLEAN LAUNDRY PROCESSING SPACE. STAFF ANTICIPATE RE-ARRANGEMENT OF MOVABLE WORKTABLES AND POTENTIALLY ADDING MORE WORKTABLES CONSIDERING ADDITIONAL SPACE THAT BECOMES AVAILABLE ONCE CLEAN LINEN STORAGE MOVES TO NEW SPACE.

CONSTRUCTION PHASING NARRATIVE -

PHASE 1 - CONSTRUCT NEW CLEAN LINEN STORAGE ROOM. THE FORMER HEALTH RECORDS SPACE WILL BE RENOVATED FIRST. HVAC CONTROLS WILL BE ADDED, AND THE SPACE WILL BE BALANCED FOR OUTWARD AIRFLOW. CLEAN LINEN IS RELOCATED ONCE THE ROOM IS COMPLETE.

PHASE 2 - CONSTRUCT NEW DRYER ENCLOSURE. ESTABLISH TEMPORARY CONSTRUCTION BARRIER BETWEEN NEW ENCLOSURE AND LAUNDRY SPACE TO PERMIT CONTINUED LAUNDRY PROCESSING OPERATIONS USING ONLY THE WEST WASHER EXTRACTOR. PROVIDE NEGATIVE PRESSURE MACHINE. REPLACE EAST WASHER/EXTRACTOR WITH NEW. CONSTRUCT OF NEW DRYER ENCLOSURE AND DUCT EXTENSION TO NORTH EXTENT OF CONSTRUCTION BARRIER. INSTALL NEW DRYERS AND SUPPORTING EQUIPMENT.

PHASE 3 - CONSTRUCTION DRYER INTAKE DUCT TO EXTERIOR. EXTENSION TO EXTERIOR ANTICIPATED TO BE THREE ADDITIONAL SUBPHASES, 1 IN THE NORTH EXTENT OF LAUNDRY SPACE ITSELF AND 2 ADDITIONAL PHASES TO CROSS CORRIDOR AND SHIPPING/RECEIVING. INTERIM LIFE SAFETY MEASURES AND SIGNAGE REQUIRED TO ADDRESS TEMPORARY OBSTRUCTION OF CORRIDOR EXIT PATH. UPON COMPLETION OF DRYER SYSTEMS AND PLACING NEW DRYERS AND EAST WASHER/EXTRACTOR IN SERVICE. COMMENCE PHASE 4.

PHASE 4 - ESTABLISH TEMPORARY CONSTRUCTION BARRIER TO PERMIT DEMOLITION OF EXISTING DRYERS AND REPLACEMENT OF WEST WASHER/EXTRACTOR.

ARCHITECT:
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THESE DRAWINGS NOTES ACCOMPANY THE PUBLISHED CONSTRUCTION DOCUMENT SPECIFICATION BOOK (PROJECT MANUAL).

2. DO NOT SCALE DRAWINGS. VERIFY DIMENSIONS IN FIELD PRIOR TO COMMENCEMENT OF WORK. REFER TO ARCHITECTURAL DRAWINGS FOR ALL DIMENSIONS.

3. ALL SUBCONTRACTORS SHALL BE LICENSED, EXPERIENCED, AND THOROUGHLY KNOWLEDGEABLE IN THEIR RESPECTIVE AREAS OF THE CONSTRUCTION INDUSTRY AND SHALL PERFORM IN A RESPONSIBLE MANNER WITH ESTABLISHED CONSTRUCTION SEQUENCE. SHALL RECOGNIZE THE PRIORITY OF THE CONSTRUCTION DOCUMENTS, AND SHALL INFORM THE PRIME CONTRACTOR OF POTENTIAL PROBLEMS WHEN THE CONSTRUCTION DOCUMENTS ARE UNCLEAR OR INCONSISTENT.

4. SUBCONTRACTORS SHALL BE RESPONSIBLE TO NOTIFY THE PRIME CONTRACTOR OF DISCREPANCIES OR CONFLICTS IN THE CONSTRUCTION DOCUMENTS FOUND DURING BIDDING AND/OR PRIOR TO PERFORMING THE WORK.

5. EXAMINATION OF BIDDING DOCUMENTS.

A. EACH BIDDER SHALL EXAMINE THE BIDDING DOCUMENTS CAREFULLY, AND NOT LATER THAN SEVEN (7) DAYS PRIOR TO THE DATE OF RECEIPT OF BIDS. SHALL MAKE WRITTEN REQUEST TO THE ENGINEER FOR INTERPRETATION OR CORRECTION OF ANY DISCREPANCIES, AMBIGUITIES, INCONSISTENCIES, OR ERRORS, THROUGH WHICH HE MAY DISCOVER. THE ENGINEER WILL ISSUE ANY INTERPRETATION OR CORRECTIONS AS AN ADDENDUM. ONLY A WRITTEN INTERPRETATION OR CORRECTION BY ADDENDUM SHALL BE BINDING. NO BIDDER SHALL RELY UPON INTERPRETATIONS OR CORRECTIONS GIVEN BY ANY OTHER METHOD. IF DISCREPANCIES, AMBIGUITIES, INCONSISTENCIES, OR ERRORS ARE NOT COVERED BY ADDENDUM OR WRITTEN DIRECTIVE, CONTRACTOR SHALL INCLUDE IN HIS BID, LABOR MATERIALS AND METHODS OF CONSTRUCTION RESULTING IN HIGHER COST. AFTER AWARD OF CONTRACT, NO ALLOWANCE OR EXTRA COMPENSATION WILL BE MADE ON BEHALF OF THE CONTRACTOR DUE TO HIS FAILURE TO MAKE THE WRITTEN REQUESTS AS DESCRIBED ABOVE.

B. FAILURE TO REQUEST CLARIFICATION DURING THE BID PERIOD OF ANY INADEQUACY, OMISSION, OR CONFLICT WILL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITIES. THE SIGNING OF THE CONTRACT WILL BE CONSIDERED AS IRREVOCABLY DENOTING THAT THE CONTRACTOR HAS A THOROUGH COMPREHENSION OF THE FULL INTENT AND SCOPE OF THE CONSTRUCTION CONTRACT DRAWINGS AND SPECIFICATIONS.

6. PROVIDE A BASE BID WHICH SHALL INCLUDE ONLY SPECIFIED EQUIPMENT OR EQUIPMENT LISTED AS EQUIVALENT. NO SUBSTITUTIONS FOR THE LISTED EQUIPMENT SHALL BE ALLOWED IN THE BASE BID.

A. THE MANUFACTURER OF EQUIPMENT OR MATERIALS FIRST NAMED ON THE DRAWINGS IS THE BASIS OF DESIGN. OTHER MANUFACTURERS LISTED ARE CONSIDERED GENERAL EQUIVALENTS ONLY.

B. COORDINATION OF GENERAL EQUIVALENTS AND SUBSTITUTIONS: WHERE CONTRACT DOCUMENTS PERMIT SELECTION FROM SEVERAL GENERAL EQUIVALENTS, OR WHERE SUBSTITUTIONS ARE AUTHORIZED, COORDINATE CLEARANCE AND OTHER INTERFACE REQUIREMENTS WITH MECHANICAL AND OTHER WORK.

1) PROVIDE NECESSARY ADDITIONAL ITEMS SO THAT SELECTED OR SUBSTITUTED ITEM OPERATES EQUIVALENT TO THE BASIS OF DESIGN AND PROPERLY FITS IN THE AVAILABLE SPACE ALLOCATED FOR THE BASIS OF DESIGN.

2) PROVIDE ALL FEATURES WHICH ARE STANDARD ON THE BASIS OF DESIGN PLUS ANY SPECIFIED OPTIONS.

3) BE RESPONSIBLE FOR ASSURING THAT PIPING, CONDUIT, DUCT, FLUE, AND OTHER SERVICE LOCATIONS FOR GENERAL EQUIVALENTS OR SUBSTITUTIONS DO NOT CAUSE ACCESS, SERVICE, OR OPERATIONAL DIFFICULTIES ANY GREATER THAN THAT WOULD BE ENCOUNTERED WITH THE BASIS DESIGN.

7. INASMUCH AS DESIGN FOR REMODEL AND/OR REHABILITATION REQUIRES THAT CERTAIN ASSUMPTIONS BE MADE REGARDING EXISTING CONDITIONS, AND BECAUSE SOME OF THESE ASSUMPTIONS CANNOT BE VERIFIED WITHOUT DESTROYING OTHER NECESSARY EQUIPMENT OR MATERIALS, THE PORTION OF THE BUILDING, THE ENGINEER CANNOT ASSURE THE OWNER OR THE CONTRACTOR THAT THE PROFESSIONAL CONSULTING SERVICES HEREIN ENCOMPASS ALL CONTINGENCIES. FIELD COORDINATION DURING CONSTRUCTION IS IMPERATIVE. MAKE REASONABLE ALLOWANCES FOR UNSEEN CONDITIONS.

8. THE EXISTING BUILDING WILL BE OCCUPIED BY THE OWNER DURING CONSTRUCTION. CONTINUED OPERATION OF THE FACILITY SHALL NOT BE HINDERED BY THIS WORK. ACCOUNT FOR ALL ADDITIONAL COSTS WHICH MAY BE INCURRED DUE TO THE DISRUPTION OF WORKERS AND ARCHITECTS' OFFICE FURNITURE, EQUIPMENT, ETC., AND DUE TO THE HOURS OF THE DAY IN WHICH AN AREA MAY BE ACCESSIBLE WHEN COMPLETING HIS BID.

9. IF NOT SPECIFICALLY DEFINED IN THESE CONSTRUCTION DOCUMENTS, MATERIALS AND/OR EQUIPMENT SHALL BE IDENTIFIED BY THE SUBCONTRACTOR WITH SUFFICIENT TIME TO ALLOW SELECTION, PURCHASE, AND DELIVERY TO MAINTAIN CONSTRUCTION SCHEDULE.

10. WORK SHALL BE PERFORMED IN A WORKMANLIKE MANNER TO THE SATISFACTION OF THE ARCHITECT, OWNER, AND ENGINEER.

11. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PERFORM HISHER WORK IN CONFORMANCE WITH ALL APPLICABLE CODES, ORDINANCES AND LIFE SAFETY FEATURES AS REQUIRED BY LOCAL, STATE, OR NATIONAL AUTHORITIES. THE CONTRACTOR SHALL VERIFY WITH THE ARCHITECT IF MODIFICATION OF HISHER WORK IS REQUIRED FOR COMPLIANCE.

12. THIS PROJECT IS SUBJECT TO ELECTRICAL REVIEW UNDER THE CITY OF ROCK SPRINGS BUILDING DEPARTMENT WHICH HAS ADOPTED THE 2022 NATIONAL ELECTRIC CODE, LIFE SAFETY CODE (NFPA 101), HEALTH CARE FACILITIES CODE (NFPA 99), INTERNATIONAL CODE COUNCIL (ICC) FAMILY OF CODES FOR BUILDING (IBC), MECHANICAL (IMC), AND PLUMBING (IPC) ARE SUBJECT TO THE AUTHORITY OF THE WYOMING DEPARTMENT OF HEALTH, OFFICE OF HEALTHCARE LICENSING AND SURVEY (HLS) WHICH FOLLOWS THE 2022 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 99, 2022 INTERNATIONAL ADMINISTRATIVE CODES, CHAPTER 3 CONSTRUCTION RULES AND REGULATION FOR HEALTHCARE FACILITIES. ADDITIONALLY, HIS OBSERVES THE 2008 VERSION OF THE AIA'S GUIDELINES FOR CONSTRUCTION OF HEALTHCARE FACILITIES AND THE 2012 VISIONS OF NFPA 99 & 101 WHICH FOLLOWS THE 2022 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 99, 2022 INTERNATIONAL ADMINISTRATIVE CODES. ALL WORK SHALL BE IN STRICT COMPLIANCE, OR EXCEED THE MINIMUM MATERIAL AND METHOD REQUIREMENTS OF THE AFOREMENTIONED CODES, ALL LOCAL ORDINANCES AND AMENDMENTS AND MANUFACTURERS INSTALLATION INSTRUCTIONS/RECOMMENDATIONS. IF A CONFLICT BETWEEN THOSE PUBLICATIONS EXISTS, THE MOST STRINGENT REQUIREMENT SHALL APPLY.

13. PAY FOR AND SECURE ALL REQUIRED PERMITS AND INSPECTIONS. PRIOR TO FINAL PAYMENT, TURN OVER TO ARCHITECT ALL CERTIFICATES OF COMPLETION.

14. WARRANTY THE INSTALLATION AGAINST DEFECTS IN MATERIALS AND WORKMANSHIP. THE WARRANTY SHALL BE FOR A PERIOD OF ONE YEAR AFTER OWNER'S OCCUPANCY. DEFECTS SHALL BE PROMPTLY REMEDIATED WITHOUT COST TO THE OWNER.

15. SUBMIT RECORD DOCUMENTS TO ENGINEER. DOCUMENTS SHALL INCLUDE ALL ADDENDUM ITEMS, CHANGE ORDERS, ALTERATIONS, REWORKINGS, ETC.

16. SYSTEMS SHALL BE COMPLETE, OPERABLE, AND READY FOR CONTINUOUS OPERATION PRIOR TO ACCEPTANCE BY THE OWNER.

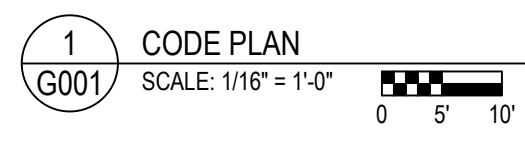
17. SYSTEMS SHALL BE TESTED FOR PROPER OPERATION. PERFORM AT A MINIMUM ALL CODE REQUIRED TESTS OR SYSTEMS. IF TESTS OF WORK ARE DEFECTIVE, CONTRACTOR SHALL MAKE CORRECTIONS NECESSARY AT NO ADDITIONAL COST TO OWNER.

18. ALL MATERIALS AND/OR EQUIPMENT SHALL BE HANDLED AND INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS AND RECOMMENDATIONS.

19. FAILURE TO RETURN, OR RELEASE ORDER FOR MATERIALS AND/OR EQUIPMENT WILL NOT BE ACCEPTED AS A REASON TO SUBSTITUTE ALTERNATE MATERIALS, EQUIPMENT, OR INSTALLATION METHODS.

20. REPAIR ALL ACCIDENTAL OR INTENTIONAL DAMAGE TO EXISTING CONSTRUCTION WITH NO NOTICEABLE DIFFERENCE IN CONTINUITY, APPEARANCE OR FUNCTION.

21. TEMPORARY HEALTH CARE SHALL BE FURNISHED BY THE GENERAL CONTRACTOR. USE OF THE PERMANENT HEALTH SYSTEM WILL NOT BE ALLOWED.



— FB1HR —	FIRE BARRIER 1 HOUR
— FB2HR —	FIRE BARRIER 2 HOUR
	HAZARDOUS AREA
	EXIT STAIR
	EXIT
	EXIT DISCHARGE



MEMORIAL HOSPITAL OF
SWEETWATER COUNTRY
LAUNDRY RENOVATION

1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	6/11/2026

SHEET NO.

G001

4/8/2025 3:22 PM 2024-03-21 2:18:05 PM PROJECT: 2645-2-4 - HHS - LAUNDRY RENOVATION 4201.DRAWING: 0002 - INFECTION PLAN

1
G002 INFECTION CONTROL PLAN
SCALE: 1/16" = 1'-0"
0 5 10'

STEP 3 Match Patient Risk Group (Low, Medium, High, Highest) w/ the planned Construction Project Type (A, B, C, D) to determine the Class of Precautions (I, II, III, IV)				
Patient Risk Group	Construction Project Activity Type			
	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

STEP 2 - Identify Patient Risk Groups that will be Affected.			
Low Risk	Medium Risk	High Risk	Highest Risk
- Office areas - Storage Rooms - Unoccupied Wards - Mechanical Rooms - Electrical Rooms	- Cardiology - Echocardiography - Endoscopy - Nuclear Medicine - Physical Therapy - Radiology/MRI - Respiratory Therapy	- CCU - Emergency Room - Labor & Delivery - Laboratories (specimen) - Newborn Nursery - Outpatient Surgery - Pediatrics - Pharmacy - Post Anesthesia Care Unit - Surgical Units	- Any area caring for immunocompromised patients - Burn Unit - Cardiac Cath Lab - Central Sterile Supply - Intensive Care Units - Medical Unit - Negative Pressure isolation rooms - Oncology - Operating rooms including C-section rooms

STEP 1 - Identify TYPE of Construction Project Activity (Type A to D)	
TYPE A	Inspection and Non-Invasive Activities. Includes, but is not limited to: - Removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet. - Painting (but not sanding) - Wall covering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
TYPE B	Small scale, short duration activities which create minimal dust. Includes, but is not limited to: - Installation of telephone and computer cabling. - Access to chase spaces. - Cutting of walls or ceilings where dust migration can be controlled.
TYPE C	Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies. Includes, but is not limited to: - Sanding of walls for painting or wall covering - Removal of floor coverings, ceiling tiles and casework - New wall construction - Minor ductwork or electrical work above ceilings - Major cabling activities - Any activity which cannot be completed within a single workshift.
TYPE D	Major demolition, renovation and construction projects Includes, but is not limited to: - Activities which require consecutive work shifts - Requires heavy demolition or removal of a complete cabling system - New construction

DESCRIPTION of Req' Infection Control Precautions by Project Class		
	During Construction Project	After Construction Project
CLASS I	- Execute work by methods to minimize raising dust from construction operations. - Immediately replace a ceiling tile displaced for visual inspection.	Clean work area upon completion or task.
CLASS II	- Provide active means to prevent airborne dust from dispersing into atmosphere. - Water mist work surfaces to control dust while cutting. - Seal unused doors with duct tape. - Block off and seal air vents. - Place dust mat at entrance and exit of work area. - Remove or isolate HVAC system in areas where work is being performed.	- Wipe work surface with disinfectant. - Contain construction waste before transport in tightly covered containers. - Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. - Remove isolation of HVAC system in areas where work is being performed.
CLASS III	- Remove or isolate HVAC system in area where work is being done to prevent contamination of duct system. - Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. - Maintain negative air pressure within work site utilizing HEPA equipped air filtration units, contain construction waste before transport in tightly covered containers. - Cover transport receptacles or carts, tape covering unless solid lid.	- Do not remove barriers from work area until completed project is inspected by the Owner's Safety Department and Infection Control Department and thoroughly cleaned by the Owner's Environmental Services Department. - Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. - Vacuum work area with HEPA filtered vacuums. - Wet mop area with disinfectant. - Remove isolation of HVAC systems in areas where work is being performed.
CLASS IV	- Isolate HVAC system in area where work is being done to prevent contamination of duct system. - Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. - Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. - Seal holes, pipes, conduits and punctures appropriately. - Construct anteroom and require all personnel to pass through this room so they can be vacuumed using HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site. - All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area. - Do not remove barriers from work area until completed project is inspected by the Owner's Safety Department and Infection Control Department and thoroughly cleaned by the Owner's Environmental Services Department.	- Remove barrier material carefully to minimize spreading of dirt and debris associated with construction. - Contain construction waste before transport in tightly covered containers. - Cover transport receptacles or carts. Tape covering unless solid lid. - Vacuum work area with HEPA filtered vacuums. - Wet mop area with disinfectant. - Remove isolation of HVAC system in areas where work is being performed.

GENERAL NOTES:
1. THIS SHEET DEPICTS THE INFECTION CONTROL RISK ASSESSMENT OF CONSTRUCTION PROJECT TYPE IN ACCORDANCE WITH INDUSTRY ACCEPTED MATRIX OF PRECAUTIONS FOR CONSTRUCTION AND RENOVATION AS ADAPTED FROM Y KENNEDY, B BARNARD OF ST LUKE EPISCOPAL HOSPITAL, HOUSTON, TX AND FAIRVIEW UNIVERSITY MEDICAL CENTER, MINNEAPOLIS, MN.

CLASS III

NEW PIPING AND REPLACEMENT PIPING SHOWN THIS SHEET EXTENDS OUTSIDE THE BOUNDARIES OF THE ARCHITECTURAL RENOVATION SCOPE AND CONSEQUENTIAL ARCHITECTURAL IMPACTS OF THOSE PATHWAYS ARE NOT SHOWN. PIPING CONTRACTOR SHALL BE RESPONSIBLE TO INCLUDE IN BID AND COORDINATE REQUIRED SCOPE TO FACILITATE THIS INSTALLATION OF NEW AND REPLACEMENT PIPING INCLUDING, BUT NOT LIMITED TO, INTERIM LIFE SAFETY MEASURES (ILSM) SHOULD EGRESS PATHWAYS BE TEMPORARILY IMPACTED. INFECTION CONTROL MEASURES, CEILING DECONSTRUCTION, AND CEILING REINSTALLATION.

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Memorial Hospital
OF SWEETWATER COUNTY

MEMORIAL HOSPITAL OF
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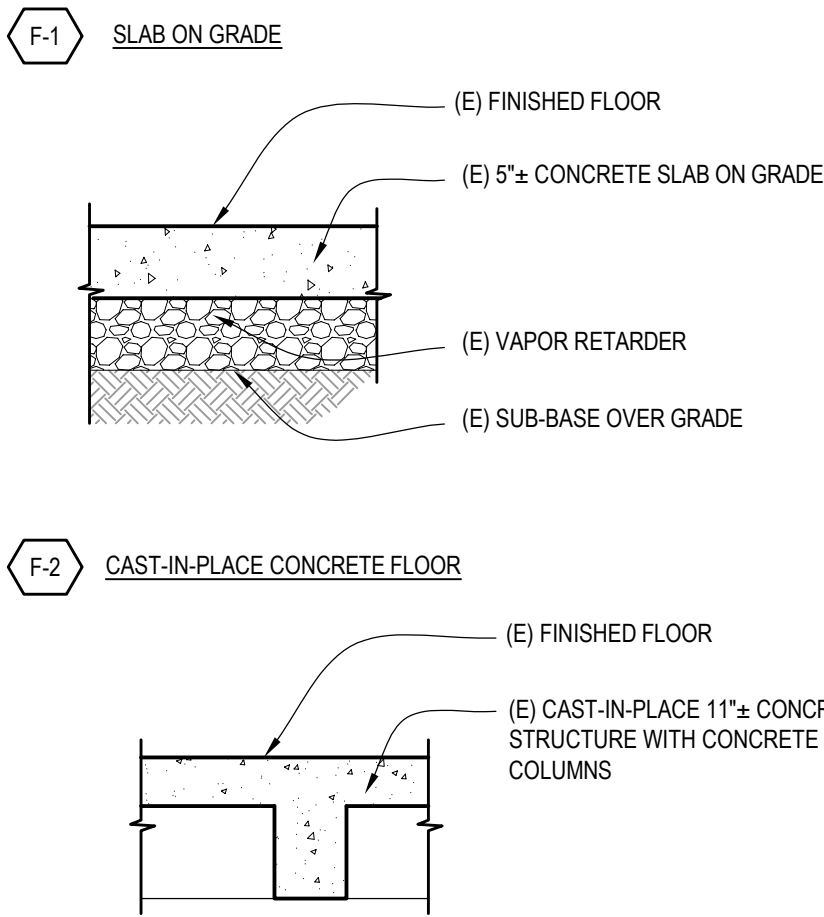
ST-B PROJECT NO.: 2645.24

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	6/11/2025

SHEET NAME
INFECTION
CONTROL PLAN

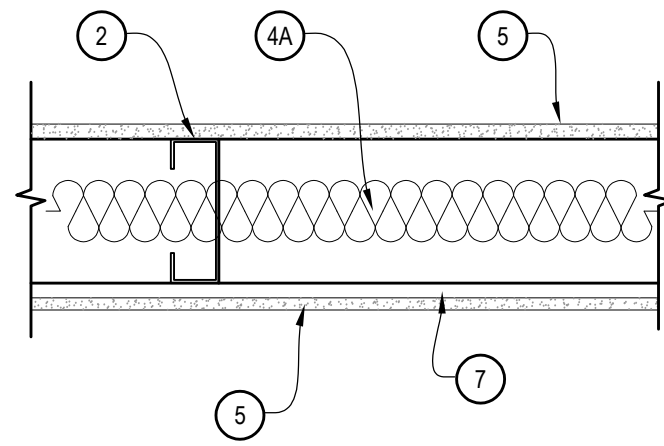
SHEET NO.
G002

FLOOR/CEILING ASSEMBLIES



RATED ASSEMBLIES

UL DESIGN NO. U419



- 1. FLOOR, SIDE AND CEILING RUNNERS - (NOT SHOWN) - FOR USE WITH ITEM 2 - CHANNEL SHAPED, FABRICATED FROM MIN 25 MSG CORROSION-PROTECTED STEEL, MIN DEPTH TO ACCOMMODATE STUD SIZE, WITH MIN 1-1/4 IN. LONG LEGS, ATTACHED TO FLOOR AND CEILING WITH FASTENERS 24 IN. OC MAX.
- 2. STEEL STUDS - CHANNEL SHAPED, FABRICATED FROM MIN 25 MSG CORROSION-PROTECTED STEEL, MIN DEPTH AS INDICATED UNDER ITEM 5, SPACED A MAX OF 24 IN. O.C. STUDS TO BE CUT 3/8 TO 3/4 IN. LESS THAN ASSEMBLY HEIGHT.
- 4A. BATTS AND BLANKETS* - (OPTIONAL) - PLACED IN STUD CAVITIES, ANY GLASS FIBER OR MINERAL WOOL INSULATION BEARING THE UL CLASSIFICATION MARKING AS TO SURFACE BURNING CHARACTERISTICS AND/OR FIRE RESISTANCE. SEE BATTS AND BLANKETS (BIB) OR (BIB2) CATEGORIES FOR NAMES OF CLASSIFIED COMPANIES.
- 5. GYPSUM BOARD - GYPSUM PANELS WITH BEVELED, SQUARE OR TAPERED EDGES, APPLIED VERTICALLY OR HORIZONTALLY, VERTICAL JOINTS CENTERED OVER STUDS AND STAGGERED ONE STUD CAVITY ON OPPOSITE SIDES OF STUDS, VERTICAL JOINTS IN ADJACENT LAYERS (MULTILAYER SYSTEMS) STAGGERED ONE STUD CAVITY. HORIZONTAL JOINTS NEED NOT BE BACKED BY STEEL FRAMING. HORIZONTAL EDGE JOINTS AND HORIZONTAL BUTT JOINTS ON OPPOSITE SIDES OF STUDS NEED NOT BE STAGGERED. HORIZONTAL EDGE JOINTS AND HORIZONTAL BUTT JOINTS IN ADJACENT LAYERS (MULTILAYER SYSTEMS) STAGGERED A MIN OF 12 IN. THE THICKNESS AND NUMBER OF LAYERS FOR THE 1 HR, 2 HR, 3 HR AND 4 HR RATINGS ARE AS FOLLOWS:

GYPSUM BOARD PROTECTION ON EACH SIDE OF WALL	MIN STUD DEPTH, IN.	NO. OF LAYERS & THICKNESS OF PANEL	MIN. THICKNESS OF INSULATION
1	3-1/2	1 LAYER, 5/8 IN. THICK	OPTIONAL

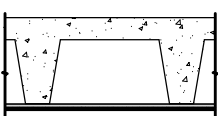
CGC INC. - 5/8 IN. THICK TYPE AR, C, IP-AR, IP-X1, IP-X2, IPC-AR, SCX, SHX, WRX, OR WRC
UNITED STATES GYPSUM CO. - 5/8 IN. TYPE SCX, SGX, SHX, WRX, IP-X1, AR, C, WRC, FRX-G, IP-AR, IP-X2, IPC-AR
USG MEXICO S A DE C V - 5/8 IN. TYPE AR, C, IP-AR, IP-X1, IP-X2, IPC-AR, SCX, SHX, WRX, WRC

- 6. FASTENERS - (NOT SHOWN) - TYPE S OR S-12 STEEL SCREWS USED TO ATTACH PANELS TO STUDS (ITEM 2) OR FURRING CHANNELS (ITEM 7), SINGLE LAYER SYSTEMS: 1 IN. LONG FOR 5/8 IN. THICK PANELS, SPACED 8 IN. OC WHEN PANELS ARE APPLIED HORIZONTALLY, OR 8 IN. O.C. ALONG VERTICAL AND BOTTOM EDGES AND 12 IN. O.C. IN THE FIELD WHEN PANELS ARE APPLIED VERTICALLY.
- 7. FURRING CHANNELS - (OPTIONAL FOR SINGLE LAYER SYSTEM) - RESILIENT FURRING CHANNELS FABRICATED FROM MIN 25 MSG CORROSION-PROTECTED STEEL, SPACED VERTICALLY A MAX OF 24 IN. OC, FLANGE PORTION ATTACHED TO EACH INTERSECTING STUD WITH 1/2 IN. LONG TYPE S-12 STEEL SCREWS.
- 8. JOINT TAPE AND COMPOUND - VINYL OR CASEIN, DRY OR PREMIXED JOINT COMPOUND APPLIED IN TWO COATS TO JOINTS AND SCREW HEADS OF OUTER LAYERS, PAPER TAPE, NOM 2 IN. WIDE, EMBEDDED IN FIRST LAYER OF COMPOUND OVER ALL JOINTS OF OUTER LAYER PANELS, PAPER TAPE AND JOINT COMPOUND MAY BE OMITTED WHEN GYPSUM PANELS ARE SUPPLIED WITH A SQUARE EDGE.
- 10. CAULKING AND SEALANTS* - (OPTIONAL, NOT SHOWN) - A BEAD OF ACOUSTICAL SEALANT APPLIED AROUND THE PARTITION PERIMETER FOR SOUND CONTROL.

UNITED STATES GYPSUM CO. - TYPE AS

* BEARING THE UL CLASSIFICATION MARK

GA FILE NO. FC 2120



- CONCRETE SLAB, JOIST(S), GYPSUM WALLBOARD
- GENERIC, 2 HOUR FIRE APPROX. CEILING WEIGHT: 3 PSF(FIRE)
FIRE TEST: PCA 1281-1, 10-67
- FIRE DESIGN:
ONE LAYER 5/8" TYPE "X" GYPSUM WALLBOARD OR GYPSUM VENEER BASE APPLIED AT RIGHT ANGLES TO RIGID ANGLES TO RIGID FURRING CHANNELS 24" O.C. WITH 1" TYPE S SCREWS 8" O.C. GYPSUM BOARD END JOINTS LOCATED OVER CONTINUOUS CHANNELS AND ATTACHED TO ADDITIONAL PIECES OF CHANNEL 54" LONG LOCATED MIDWAY BETWEEN CONTINUOUS CHANNELS AT END JOINTS. FURRING CHANNELS 24" O.C. SUSPENDED FROM 5-1/2" PRECAST REINFORCED CONCRETE JOISTS 35" O.C. WITH 21 GA. GALVANIZED STEEL HANGER STRAPS FASTENED TO SIDES OF JOISTS, JOIST LEG DEPTH, 10".

WALL TYPES GENERAL NOTES

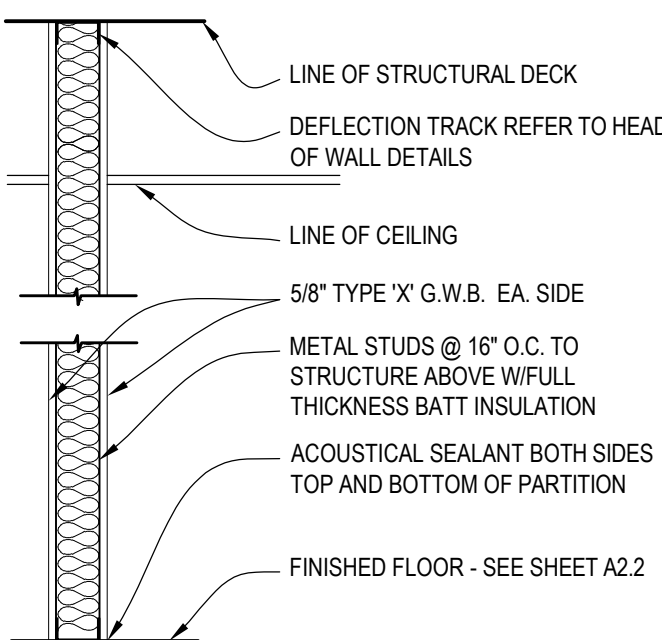
- WALL & PARTITION TYPES ARE REFERENCED BY A WALL & PARTITION TYPE SYMBOL.
- WALL & PARTITION TYPES ARE DEFINED FOR EACH CONDITION IN THE PROJECT. CONSTRUCTION COMPONENTS INDICATED ARE THE MINIMUM THAT WILL BE ACCEPTED FOR EACH SPECIFIC WALL, PARTITION TYPE. SEE THE SPECIFICATIONS FOR ADDITIONAL INFORMATION, INCLUDING BUT NOT LIMITED TO STUD FLANGE WIDTHS, INTERIOR AND EXTERIOR HEADER AND JAMB STUD DESIGN, DETAILING REQUIREMENTS, ETC. ADJUST GAUGE AND SPACING OF STUDS FOR TALL AND/OR EXTERIOR WALLS, OR OTHER SPECIAL CONDITIONS AS OUTLINED IN THE DRAWINGS AND SPECIFICATIONS.
- ACOUSTICAL BATT INSULATION SHALL BE AS SPECIFIED UNLESS OTHERWISE NOTED ON THIS SCHEDULE AT ALL PARTITIONS PENETRATIONS ACOUSTICALLY SEALED.
- "GWB" (GYPSUM WALL BOARD) IS USED GENERICALLY IN THE WALL & PARTITION TYPE SCHEDULE AND REPRESENTS A VARIETY OF GYPSUM AND CEMENTITIOUS BOARD PRODUCTS. THESE INCLUDE THE FOLLOWING AND THEIR FIRE RATED COUNTERPARTS AS SPECIFIED:
 - (TYPE-X) SHALL BE FIRE-RATED TYPE-X GYPSUM WALLBOARD CONSISTING OF A SPECIALLY TREATED PAPER FACE AND GYPSUM CORE PANEL AT ALL FIRE RATED WALL ASSEMBLIES, ALL LOCATIONS, U.N.O.
- WALLS & PARTITIONS ARE DIMENSIONED ON THE PLANS TO FACE OF FRAMING AT NEW CONSTRUCTION AND FACE OF EXISTING FINISH AT EXISTING UNLESS SHOWN OTHERWISE. WALLS & PARTITIONS NOT DIMENSIONED ARE LOCATED BY COLUMN CENTERLINE, WINDOW MULLION OR OTHER SUCH OBVIOUS REGULATOR. GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE WALL AND PARTITION LAYOUTS.
- DIFFERING WALL & PARTITION TYPES SHALL ALIGN SO WALL PLANES CONTINUE UNBROKEN WITHIN ROOMS AND ADJACENT FACE OF FINISHES ALIGN UNLESS OTHERWISE INDICATED.
- UNBALANCED STUD WALL & PARTITION TYPES SHALL HAVE THE SIDE WITH THE LARGEST NUMBER OF GWB LAYERS LOCATED ON THE SAME SIDE OF THE PARTITION AS THE WALL TAG IS SHOWN IN THE PLANS. UNBALANCED WALL & PARTITION TYPES SHALL ALIGN SO WALL PLANES CONTINUE UNBROKEN WITH ROOMS AND ADJACENT FACES UNLESS OTHERWISE NOTED.
- TYPICAL WALL AND PARTITION FRAMING, FACING AND INSULATION SHALL EXTEND FULL HEIGHT TO UNDERSIDE OF FLOOR DECK OR ROOF DECK STRUCTURE ABOVE AT CORRIDOR AND OTHER RATED ASSEMBLIES, AND 4" ABOVE CEILING UNLESS NOTED OTHERWISE.
- FIRE TEST AND SOUND TEST NUMBERS ARE BASED ON PUBLISHED STANDARDS FROM THE FOLLOWING CODES AND ASSOCIATIONS: (IBC) INTERNATIONAL BUILDING CODE, TABLE 7-B, RATED FIRE RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS, (UL) UNDERWRITERS LABORATORIES, FIRE RESISTANCE DIRECTORY FOR WALLS AND PARTITIONS.
- BLOCKING: PROVIDE AND INSTALL SOLID BLOCKING OR BACKING FOR WALL AND CEILING MOUNTED ITEMS IN ACCORDANCE WITH THE SPECIFICATIONS & DETAILS ON SHEET A105.
- CONTROL JOINTS AT FRAMED WALLS AND PARTITIONS: AT STRUCTURAL COLUMNS AND AT LOCATIONS INDICATED IN SPECIFICATIONS - MATCH EXISTING CONDITIONS.
- INFILL WALLS: ALIGN BOTH FINISH FACES OF INFILL WALL WITH EXISTING ADJACENT WALL.
- ACOUSTICAL OUTLET BACKER PADS: IN WALLS WITH NOTED STC AND FIRE RATINGS, INSTALL BACKER PADS BEHIND OUTLET BOXES PER DIV 26.

INTERIOR WALL TYPES

TYPE	STUD SIZE/SPACING
A1	3 5/8" METAL STUDS
A2	3 5/8" METAL STUDS TO 4" ABOVE CEILING
A3	(E) 6" METAL STUDS

FIRE RATING:	NON-RATED*
ASSEMBLY:	GA ASSEMBLY
MINIMUM STC:	49

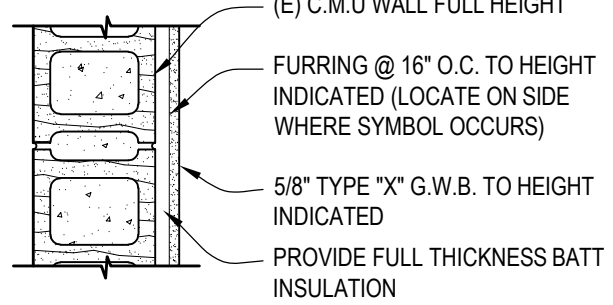
* SMOKE SEALED WHERE INDICATED



TYPE	STUD SIZE/SPACING
C1	(E) CMU
C2	(E) CMU WITH 7/8" HAT CHANNEL (FULL HEIGHT)
C3	(E) CMU WITH 3-5/8" METAL STUD WITH BATT INSULATION (FULL HEIGHT)

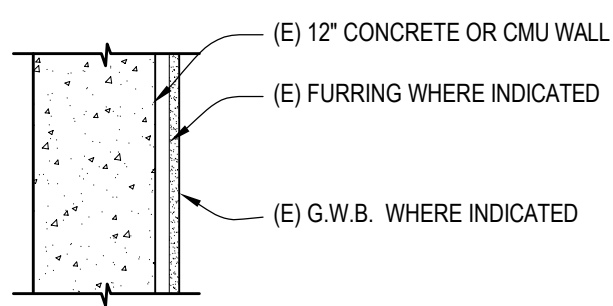
FIRE RATING:	(E) RATED*
ASSEMBLY:	-
MINIMUM STC:	-

* SMOKE SEALED WHERE INDICATED - SEE WALL LEGEND AND FLOOR PLANS FOR LOCATIONS, FIELD VERIFY WITH EXISTING CONDITIONS



TYPE	STUD SIZE/SPACING
E1	(E) EIFS OVER EXTERIOR CMU BLOCK WALL
E2	(E) 12" CONCRETE WITH FURRING AT INTERIOR FACE

FIRE RATING:	(E) RATED*
ASSEMBLY:	-
MINIMUM STC:	-



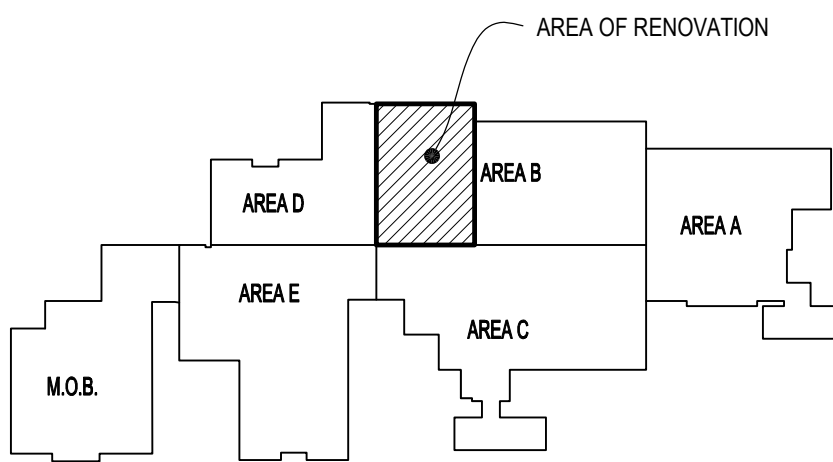
GENERAL NOTES

- FIELD VERIFY (E) CONDITIONS, SOME UNKNOWN CONDITIONS MAY EXIST. THE CONTRACTOR SHALL VISIT THE SITE TO BECOME FAMILIAR WITH THE EXTENT OF THE WORK. COORDINATE BETWEEN ALL ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND PLUMBING DRAWINGS FOR COMPLETE SCOPE OF WORK. IF A CONFLICT, DISCREPANCY, OR OMISSION BETWEEN ANY TRADE OCCURS PRIOR TO BID AND NO CLARIFICATION IN WRITING IS PROVIDED, THE CONTRACTOR SHALL ASSUME WORST CASE, AND BID ALL MEANS NECESSARY TO COMPLETE THE SCOPE OF WORK IN FULL.
- LEGALLY DISPOSE OF ALL MATERIALS, FILL OR OTHERWISE OFF SITE, UNLESS NOTED OTHERWISE.
- TAKE PROPER PRECAUTIONS DURING CONSTRUCTION & DEMOLITION TO PROTECT THE (E) FINISHES THAT ARE TO REMAIN. SEE ROOM FINISH SCHEDULE AND FLOOR PLANS. DAMAGES TO (E) MATERIALS TO REMAIN SHALL BE GENERAL CONTRACTOR RESPONSIBILITY TO REPAIR/REPLACE TO SAME CONDITION AS PREVIOUS.
- THESE PLANS ILLUSTRATE THE GENERAL PARAMETERS OF THE BUILDING AND DO NOT INCLUDE ALL STRUCTURAL, MECHANICAL, PLUMBING, ELECTRICAL, OR SECURITY DEVICES. IF A CONFLICT OR DISCREPANCY OCCURS BETWEEN FLOOR PLANS OF ARCHITECTURAL, MECHANICAL, OR ELECTRICAL, CONTACT ARCHITECT FOR CLARIFICATION.
- REFER TO SPECIFICATIONS FOR ANY ADDITIONAL REQUIREMENTS AND SCOPE OF WORK. THE DRAWINGS AND SPECIFICATIONS IN RELATION TO EACH OTHER ARE CONSIDERED ADDITIVE AND COMPREHENSIVE. IF A SCOPE ITEM OCCURS ON THE DRAWINGS, IT MAY NOT OCCUR IN THE SPECIFICATIONS (AND VICE VERSA), BUT IT IS STILL PART OF THE ENTIRE PROJECT AND IS INCLUDED IN THE SCOPE OF WORK.
- THE GENERAL CONTRACTOR IS RESPONSIBLE FOR THE COORDINATION OF ALL WORK, INCLUDING LAYOUT AND DIMENSION VERIFICATION, MATERIALS COORDINATION, SHOP DRAWING REVIEW, AND THE WORK OF SUBCONTRACTORS. ANY DISCREPANCIES OR OMISSIONS DISCOVERED IN THE COURSE OF THE WORK SHALL BE IMMEDIATELY REPORTED TO THE ARCHITECT FOR RESOLUTION. CONTINUATION OF WORK WITHOUT NOTIFICATION OF DISCREPANCIES RELIEVES THE ARCHITECT FROM ALL CONSEQUENCES.
- G.W.B. FINISHES COMPLY WITH THE FOLLOWING REQUIREMENTS IN ADDITION TO SPECIFICATIONS:
 - A. G.W.B. FINISHING PREPARATION/APPLICATION:
INSTALL PRIMER PRIOR TO APPLICATION OF TEXTURE OR OTHER FINISHES - COMPLY WITH SPECIFICATIONS AND MANUFACTURER INSTALLATION INSTRUCTIONS. EXECUTION: PREVENT TEXTURE FINISHES AND PAINT FROM COMING INTO CONTACT WITH SURFACES NOT INDICATED TO RECEIVE TEXTURE FINISH BY COVERING THEM WITH MASKING AGENTS, POLYETHYLENE FILM, OR OTHER MEANS. IF, DESPITE THESE PRECAUTIONS, TEXTURE FINISHES CONTACT THESE SURFACES, IMMEDIATELY REMOVE DROPPINGS AND OVERSPRAY TO PREVENT DAMAGE. ACCORDING TO TEXTURE-FINISH MANUFACTURER'S WRITTEN INSTRUCTIONS. REFER TO ROOM FINISH SCHEDULE FOR TEXTURE FINISHES.
 - B. G.W.B. PAINTING: PREPARATION/APPLICATION:
COMPLY WITH THE MANUFACTURER'S WRITTEN INSTRUCTIONS AND RECOMMENDATIONS IN "MPI ARCHITECTURAL PAINTING SPECIFICATION MANUAL" APPLICABLE TO SUBSTRATES AND PAINT SYSTEMS INDICATED. APPLY PAINTS ACCORDING TO THE MANUFACTURER'S WRITTEN INSTRUCTIONS AND TO RECOMMENDATIONS IN "MPI MANUAL." EXECUTION: VERIFY SUITABILITY OF SUBSTRATES, INCLUDING SURFACE CONDITIONS AND COMPATIBILITY WITH FINISHES AND PRIMERS. REFER TO APPROVED COLOR LOG FOR PAINT COLORS.
- SEE MECHANICAL, ELECTRICAL, AND PLUMBING PLANS FOR ADDITIONAL INFORMATION.
- SEAL ALL PENETRATIONS THROUGH WALLS, AT TOP AND ENDS OF WALLS.
- SEE SHEETS A101 & A102 FOR AREAS OF ARCHITECTURAL DEMOLITION, REFER TO SPECIFIC TRADES FOR ADDITIONAL SCOPE OF WORK.
- FIELD VERIFY AND MAINTAIN ALL (E) RATED WALL AND CEILING/ROOF ASSEMBLIES, SEE SHEET CR1.1 FOR CODE REVIEW.
- SEE WALL TYPE ON THIS SHEET FOR RATED ASSEMBLY INFO. ALL NEW WALLS SHALL EXTEND TO BOTTOM OF ROOF DECK PER DETAILS, UNLESS DIRECTED OTHERWISE.
- SEE REFLECTED CEILING PLANS ON SHEET A102, MECHANICAL, AND ELECTRICAL FOR CEILING INFORMATION, INCLUDING BUT NOT LIMITED TO LIGHTING AND CEILING DEVICES.
- ALL G.W.B. TO BE 5/8" U.N.O. - SEE WALL TYPES AND CODE REVIEW PLANS FOR FIRE-RATED LOCATIONS. PROVIDE CASING BEAD & SEALANT WHERE G.W.B. ABUTS DISSIMILAR MATERIAL.
- PROVIDE PROTECTION FOR FLOORS, WALLS, & CEILING AT ALL (E) CONDITIONS TO REMAIN, INCLUDING TRAFFIC AREAS FOR DEMOLITION REMOVAL IN COMMON BUILDING AREAS. GC IS RESPONSIBLE FOR REPAIR OR REPLACEMENT OF ANY DAMAGED FINISHES.
- COORDINATE W/ BUILDING OWNER DURING DEMOLITION TO DETERMINE WHETHER (E) FIRE & SMOKE DETECTION SYSTEMS ARE TO BE BAGGED, PROTECTED & REMAIN IN OPERATION OR TO BE TAKEN OFF LINE.
- CENTER LIGHT FIXTURES, SMOKE DETECTORS, ETC. IN CEILING TILES OR SPACES AS SHOWN. LIGHT FIXTURES WHICH OCCUR IN G.W.B. CEILING ARE TO BE CENTERED BETWEEN WALLS AND/OR CASEWORK UNLESS OTHERWISE NOTED.
- COORDINATE PLACEMENT OF MECHANICAL, PLUMBING, TECHNOLOGY DATA AND ELECTRICAL ITEMS TO AVOID CONFLICT WITH OBSTRUCTIONS (INCLUDING STRUCTURE) ABOVE CEILING.
- PROVIDE CEILING/WALL ACCESS PANELS WHERE REQUIRED PER MECHANICAL, ELECTRICAL, AND PLUMBING. FIELD COORDINATE QUANTITY AND LOCATIONS.
- NOT ALL STRUCTURAL, MECHANICAL, ELECTRICAL, PLUMBING & TECHNOLOGY ARE SHOWN FOR A CLARITY OF DRAWINGS. REFERENCE ENTIRE DRAWING SET FOR COMPLETE SCOPE OF WORK AND COORDINATION.
- PROVIDE NECESSARY SHORING/BRACING OF ITEMS TO EXECUTE THE WORK. REFER TO STRUCTURAL FOR ADDITIONAL INFORMATION.
- CONTRACTOR TO COORDINATE AND PROVIDE PENETRATIONS AT (E) CONSTRUCTION WHERE NEW ARE REQUIRED AND AS INDICATED ON MECHANICAL, ELECTRICAL, AND PLUMBING DRAWINGS.
- IF SUSPECTED ASBESTOS CONTAINING MATERIALS ARE ENCOUNTERED DURING ANY PORTION OF WORK, NOTIFY THE OWNER PRIOR TO THE START OF DEMOLITION.
- OWNER TO RELOCATE ALL GOODS, STORED ITEMS, SHELVING, FURNITURE AND ANY ITEMS NOT ATTACHED TO THE (E) BUILDING UNLESS NOTED OTHERWISE. VERIFY & COORDINATE ALL REQUIREMENTS FOR OWNER-FURNISHED ITEMS PRIOR TO PERFORMANCE OF WORK THAT MAY INTERFACE WITH SUCH ITEMS.
- COMPLY WITH MANUFACTURER INSTALLATION REQUIREMENTS, UNLESS NOTED OTHERWISE.
- MAINTAIN (E) CEILING RETURN AIR PLENUMS AS INDICATED PER MECHANICAL. PROVIDE NON-COMBUSTIBLE MATERIALS ONLY AS REQUIRED.
- THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING ALL OF THE REFUSE OFF OF THE SITE UNLESS NOTED OTHERWISE.
- DASHED LINES INDICATE BARRIER FREE A.D.A. CLEARANCE AREAS.
- MAINTAIN EXISTING CEILING RETURN AIR PLENUMS AS INDICATED PER MECHANICAL. PROVIDE NON-COMBUSTIBLE MATERIALS ONLY AS REQUIRED.
- COORDINATE W/ BUILDING OWNER DURING DEMOLITION TO DETERMINE WHETHER EXISTING FIRE & SMOKE DETECTION SYSTEMS ARE TO BE BAGGED, PROTECTED & REMAIN IN OPERATION OR TO BE TAKEN OFF LINE.
- PROVIDE PROTECTION FOR FLOORS, WALLS, & CEILING AT ALL EXISTING CONDITIONS TO REMAIN, INCLUDING TRAFFIC AREA FOR DEMOLITION REMOVAL IN COMMON BUILDING AREAS & FREIGHT ELEVATORS. DAMAGED FLOORS WILL BE REPLACED @ NO COST TO OWNER.

LEGEND

- SMOKE/SEALED PARTITION
- - - 1 HOUR SMOKE BARRIER
- - - 1 HOUR FIRE BARRIER OR FIRE RATED EXTERIOR WALL
- - - 2 HOUR FIRE BARRIER (FIRE AREA SEPARATION WALL)
- EXISTING WALL CONSTRUCTION

KEY PLAN



ARCH. DRAWING INDEX

ARCHITECTURAL	
A100	ARCHITECTURAL GENERAL NOTES AND ASSEMBLIES
A101	ARCHITECTURAL BASEMENT ENLARGED FLOOR PLAN
A102	ARCHITECTURAL BASEMENT ENLARGED CEILING PLAN
A105	ARCHITECTURAL BUILDING SECTIONS AND DETAILS

LICENSED ARCHITECT
TAYLOR LEE
B-0000
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ST+B
engineering
2018 general bid & build
(307) 332-0554

R4
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4025 NEWARK RD
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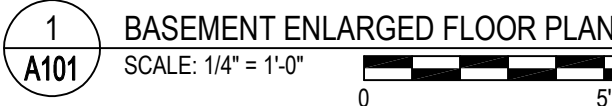


MEMORIAL HOSPITAL OF SWEETWATER
COUNTRY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE
ROCK SPRINGS, WYOMING

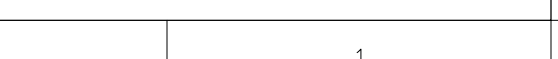
ST + B Project No.:		2645.24
Plan One / Architects Project No.:		2602
NO	SUBMISSION	DATE
1	OHLS PRELIMINARY REVIEW	2/12/2026
2	PERMIT	4/8/2026
3	ISSUE FOR BID	6/11/2026

Sheet Name
**ARCHITECTURAL
GENERAL NOTES &
ASSEMBLIES**

Sheet No.
A100



 (E) SMOKE/SEALED PARTITION
 1 HOUR FIRE PARTITION
 (E) 1 HOUR SMOKE BARRIER
 (E) 2 HOUR FIRE PARTITION





- GENERAL NOTES:
- REFER TO SHEET A100 FOR ADDITIONAL ARCHITECTURAL GENERAL NOTES THAT PERTAIN TO THIS SHEET. REFER TO G SERIES FOR ADDITIONAL SCOPE OF WORK AND PHASING REQUIREMENTS. LAUNDRY FACILITY TO REMAIN IN OPERATION FOR THE DURATION OF THE PROJECT - COORDINATE WITH OWNER TO CONFIRM PHASING PLANS WITH THE ANTICIPATION OWNER OCCUPANCY
 - REFER TO SHEET A105 FOR TYPICAL BUILDING SECTION AND DETAILS.
 - REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION, TYPICAL AT ALL.
 - SEE SHEET A100 FOR WALL TYPES AND RATED ASSEMBLIES.
 - SEE PLUMBING AND MECHANICAL PLANS FOR ADDITIONAL SCOPE OF WORK.
 - PROVIDE ADDITIONAL SPRINKLER HEADS AS REQUIRED - SEE MECHANICAL/PLUMBING FOR ADDITIONAL INFORMATION.
 - SEAL ALL PENETRATIONS AT RATED WALLS.
 - GC SHALL REPLACE ANY DAMAGED CEILING TILES TO MATCH (E) AND TOUCH UP/REPLACE ANY DAMAGED CEILING GRID AS OCCURS. TAKE PRECAUTIONS TO NOT LEAVE MARKS FROM TEMPORARY PARTITIONS OR OTHER CONSTRUCTION METHODS.
- KEYNOTES:
- (E) CEILING GRID TO REMAIN, SALVAGE & REINSTALL CEILING TILES & CEILING DEVICES TO EXTENT REQUIRED TO COMPLETE SCOPE OF WORK ABOVE CEILING - SEE MECH. PLUMB. & ELEC. PLANS FOR SCOPE OF WORK ABOVE CEILING.
 - (E) CLEARANCES: 11'-2" BOTTOM OF (E) CAST IN PLACE STRUCTURE, 9'-4" BOTTOM OF (E) SEWER PIPES, 8'-3" BOTTOM OF (E) PIPING - FIELD VERIFY AND COORDINATE NEW SYSTEMS WITH (E) CONDITIONS TO MAINTAIN 8'-0" WORKING CLEARANCES FOR THE ENTIRE ROOM. REMOVE (E) ELECTRICAL DEVICES, LIGHTS, AND MECHANICAL DUCTWORK AND PLUMBING DEVICES TO EXTENTS REQUIRED FOR NEW CONSTRUCTION - SEE MECHANICAL, ELECTRICAL, AND PLUMBING - COORDINATE WITH (E) CONDITIONS AND PROVIDE NEW SEALANTS WHERE PENETRATIONS OCCUR AT (E) CONSTRUCTION, TYPICAL, UNLESS NOTED OTHERWISE.
 - ALL NEW INTERIOR PARTITIONS EXTEND WALLS TO BOTTOM OF (E) DECK - SEE WALL TYPES AND DETAILS ON SHEET A105
 - PROVIDE 1-HOUR RATED CEILING ASSEMBLY: PAINTED 5/8" TYPE "X" GYP. BD. CEILING FINISH W/ LEVEL 5 SMOOTH TEXTURE. PROVIDE ACCESS PANELS WHERE REQUIRED - SEE MECHANICAL/PLUMBING (GA FILE NO FC 2120, SEE SHEET A100)
 - (E) BULKHEAD TO REMAIN
 - (E) ROOMS, NIC, UNLESS NOTED OTHERWISE - SEE MECHANICAL & ELECTRICAL
 - (E) TILES IN ACOUSTICAL CEILING GRID TO REMAIN - TAKE PRECAUTIONS TO NOT DAMAGE (E) TILES WHERE REMOVED FOR ACCESS. REPLACE ALL DAMAGED TILES, MATCH (E)
 - REMOVE (E) LIGHT FIXTURES, MECHANICAL DEVICES, ETC. TO EXTENTS REQUIRED TO INSTALL NEW CONSTRUCTION - SEE MECHANICAL AND ELECTRICAL FOR ADDITIONAL INFORMATION. CLEARANCES OF (E) 7'-6" TO BOTTOM WEDGES, 7'-0" BOTTOM FENCE ENCLOSURE
 - PROVIDE BULKHEAD ABOVE EQUIPMENT FOR THE FULL LENGTH REQUIRED - PROVIDE NEOPRENE SEAL WHERE ABUTS EQUIPMENT TO EXTENTS REQUIRED - SEE DETAIL 10A105
 - REMOVE (E) CMU WALL PARTITION FROM BOTTOM OF STRUCTURE ABOVE TO BOTTOM OF NEW DUCT/PIPING TO EXTENTS REQUIRED TO INSTALL NEW EQUIPMENT - PROVIDE METAL STUD INFILL, SIM. TO WALL TYPE A1 WHERE GAP OCCURS WITHIN STRUCTURAL CONCRETE BAYS EXCEEDING ALLOWABLE INFILL BY FIREPROOFING MANUFACTURER - SEE SPECIFICATIONS AND MECHANICAL - SEE DETAIL 8A105
 - (E) CAST-IN-PLACE CONCRETE BEAM WITH FRAMED WINDOW OPENING TO REMAIN - SEE SHEET A101 AND MECHANICAL - SEE DETAIL 4A105
 - PROVIDE BULKHEAD AT SOFFIT UP TO STRUCTURE ABOVE
 - PROVIDE T-GRID CEILING EXPANSION JOINT, MATCH (E) JOINT WIDTH - BASIS-OF-DESIGN: INPRO 116 CEILING SERIES - COLOR: BRIGHT WHITE
 - PROVIDE DROPPED CEILING TILE INSTALLATION WITH VERTICAL TRANSITIONS WHERE DUCT CROSSINGS OCCUR AT EXISTING BEAM - PROVIDE MINIMUM 7'-0" HEAD CLEARANCE. PROVIDE FASCIA TRIM PER CEILING GRID MANUFACTURER. BASIS-OF-DESIGN USG COMPASSO ELITE AAS
 - PROVIDE VERTICAL TRANSITIONS AT EQUIPMENT - PROVIDE MINIMUM CLEARANCE AS REQUIRED, COORDINATE WITH OWNER. PROVIDE FASCIA TRIM PER CEILING GRID MANUFACTURER. BASIS-OF-DESIGN USG COMPASSO ELITE AAS

- CEILING TYPES
- (E) 24" x 24" SUSPENDED CEILING & GRID
 - (E) EXPOSED STRUCTURAL CEILING
 - 24x24 SUSPENDED VINYL COATED GYPSUM BASED TILES IN EXPOSED T-GRID
 - EPOXY PAINTED LEVEL 5 SMOOTH FINISH G.W.B. CEILING
- LEGEND
- RECESSED LIGHT FIXTURES - SEE ELECTRICAL
 - SURFACE MOUNTED OR SUSPENDED LIGHT FIXTURES - SEE ELECTRICAL
 - EXIT LIGHTS - SEE ELECTRICAL
 - SUPPLY - SEE MECHANICAL
 - RETURN - SEE MECHANICAL
 - EXHAUST FAN - SEE MECHANICAL
 - PAINTED G.W.B. CEILING - LEVEL 5 FINISH (1-HOUR RATED) GA FILE NO. FC2120 OR APPROVED EQUAL
 - 24"x24" SUSPENDED GYPSUM PANEL CEILING IN EXPOSED T-GRID (NON-RATED & UNSEALED)
 - TYPICAL SPRINKLER HEAD LOCATIONS: PLACE SPRINKLER HEAD IN CEILING GRID AS DIAGRAMMED AT LEFT. PLACE HEAD IN CENTER OF 24" TILE OR IN CENTER OF 12 OF A 24" TILE. VERIFY LOCATION OF ALL SPRINKLER HEADS PRIOR TO FINAL PLACEMENT - SPRINKLER HEADS NOT SHOWN ON ARCHITECTURAL SHEETS. COORDINATE WITH PLUMBING FOR LOCATIONS
 - (E) SMOKE/SEALED PARTITION
 - 1 HOUR FIRE PARTITION
 - (E) 1 HOUR SMOKE BARRIER
 - (E) 2 HOUR FIRE PARTITION
- NOTE: SHOULD A CONFLICT OF MECH & ELEC DEVICES OCCUR BETWEEN THE ARCHITECTURAL REFLECTED CEILING PLAN AND THE MECHANICAL/ELECTRICAL DRAWINGS, THE LATTER SHALL PREVAIL.

1 A102 BASEMENT ENLARGED CEILING PLAN
SCALE: 1/4" = 1'-0"

LICENSED ARCHITECT
TAYLOR LEE
B-0000
STATE OF WYOMING

ST+B
engineering
2500 grossess, 100 sq
feet, 100
garden, co. 1000

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400 NEW YORK
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Memorial Hospital
OF SWEETWATER COUNTY

MEMORIAL HOSPITAL OF SWEETWATER
COUNTRY
LAUNDRY RENOVATION

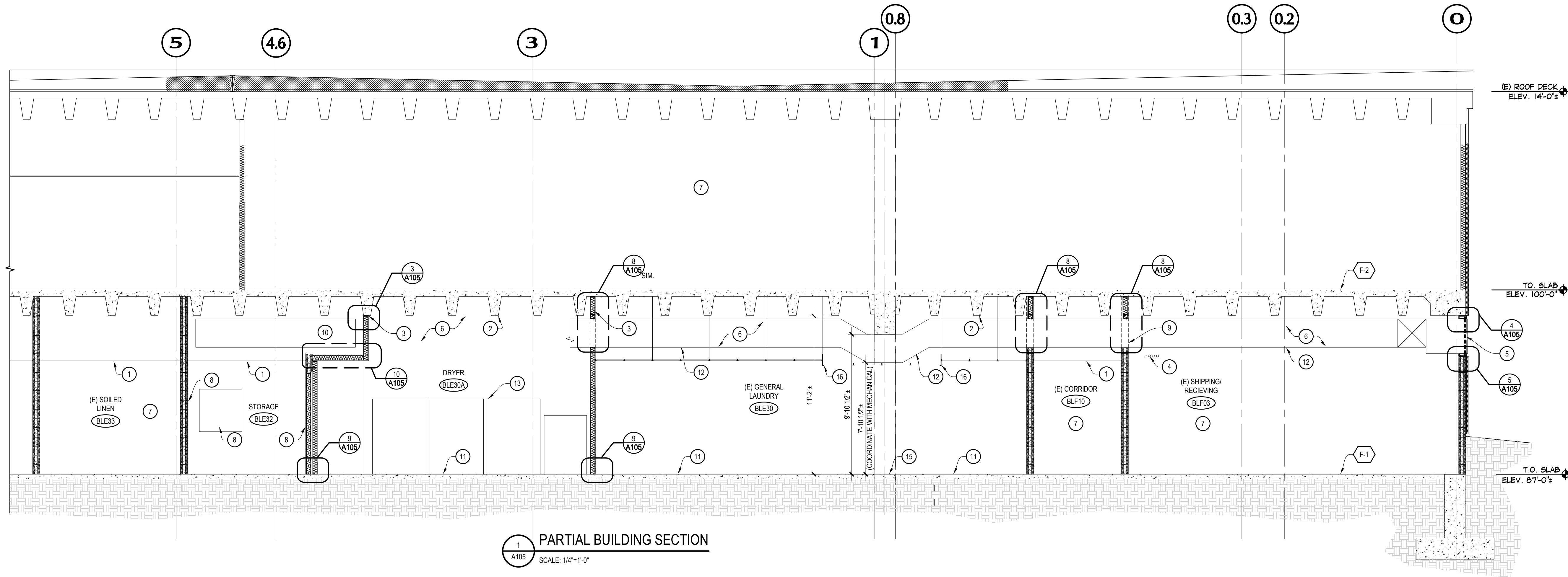
1200 COLLEGE DRIVE
ROCK SPRINGS, WYOMING

ST+B Project No.: 2645.24
Plan One / Architects Project No.: 2602

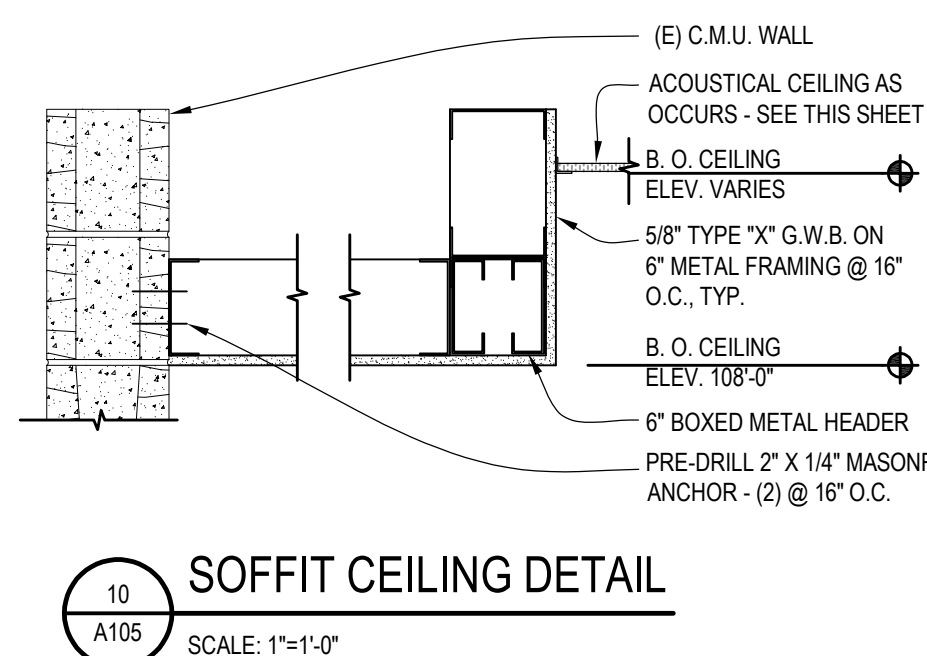
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Sheet Name
ARCHITECTURAL
BASEMENT ENLARGED
CEILING PLAN

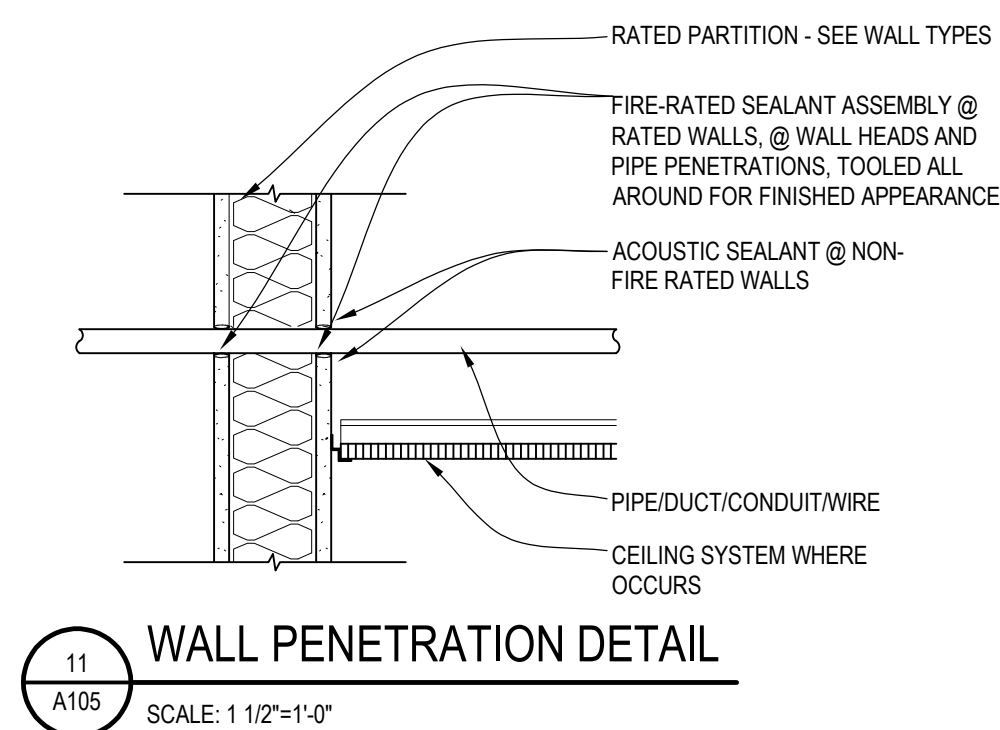
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A102



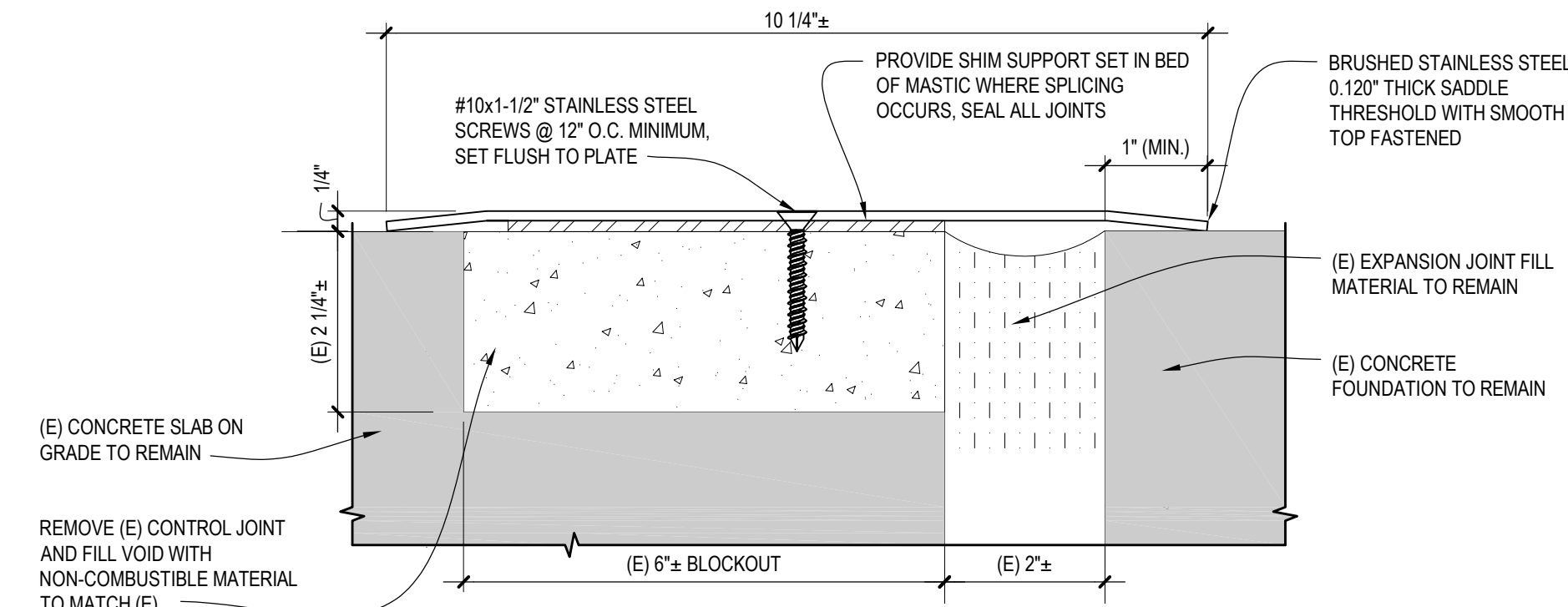
1 PARTIAL BUILDING SECTION
A105 SCALE: 1/4"=1'-0"



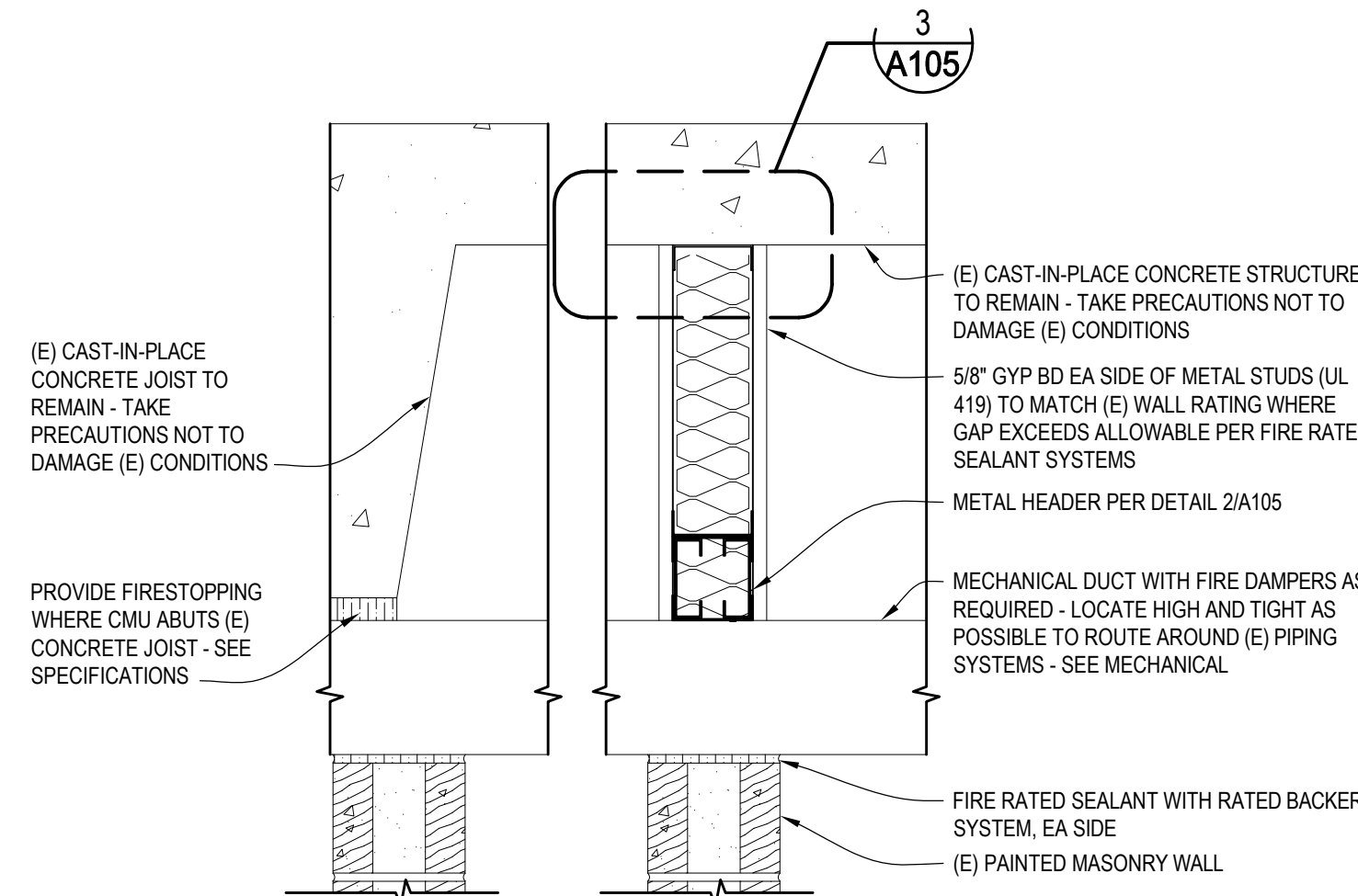
10 SOFFIT CEILING DETAIL
A105 SCALE: 1"=1'-0"



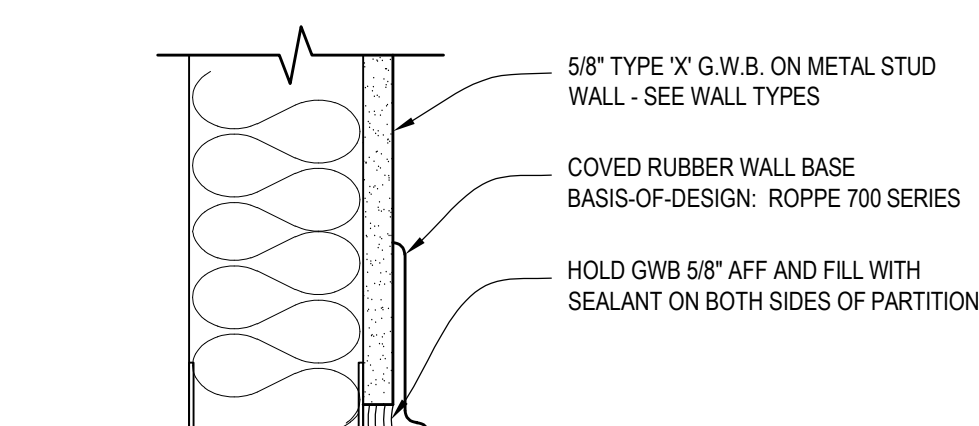
11 WALL PENETRATION DETAIL
A105 SCALE: 1 1/2"=1'-0"



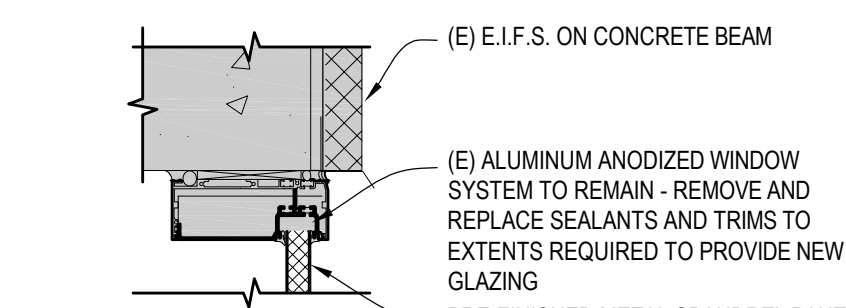
7 EXPANSION JOINT DETAIL
A105 SCALE: 6"=1'-0"



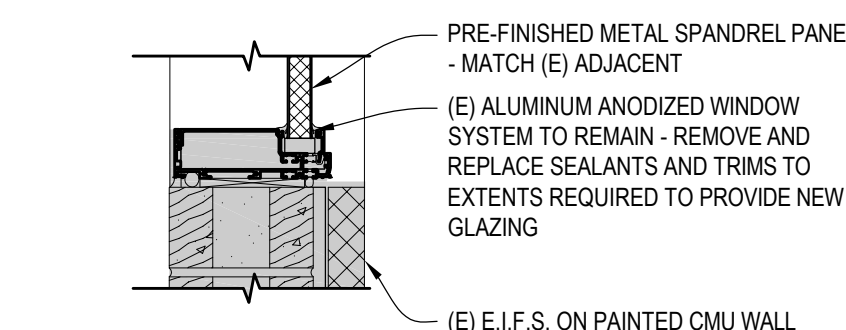
8 DUCT PENETRATION DETAIL
A105 SCALE: 1-1/2"=1'-0"



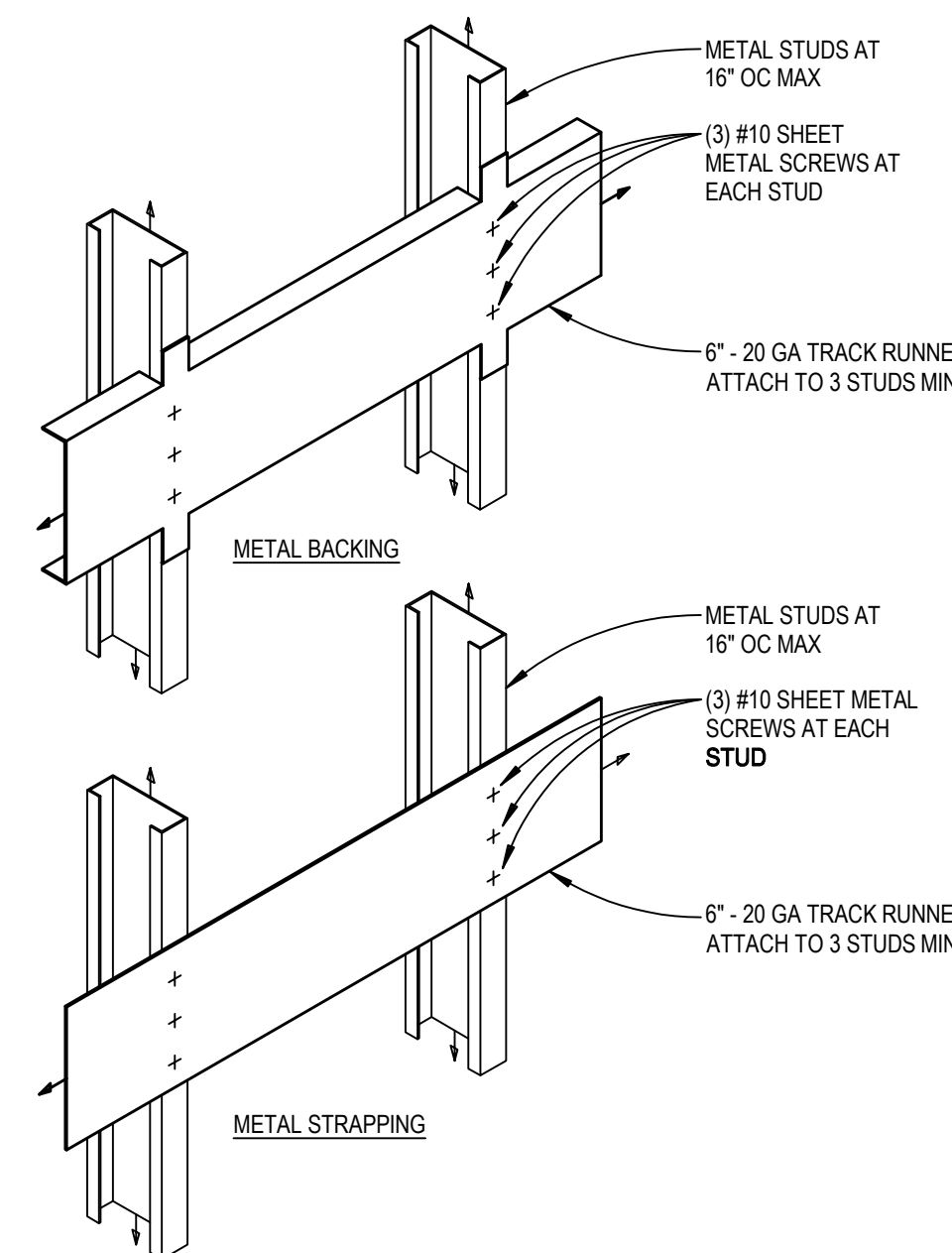
9 BOTTOM OF WALL DETAIL
A105 SCALE: 3"=1'-0"



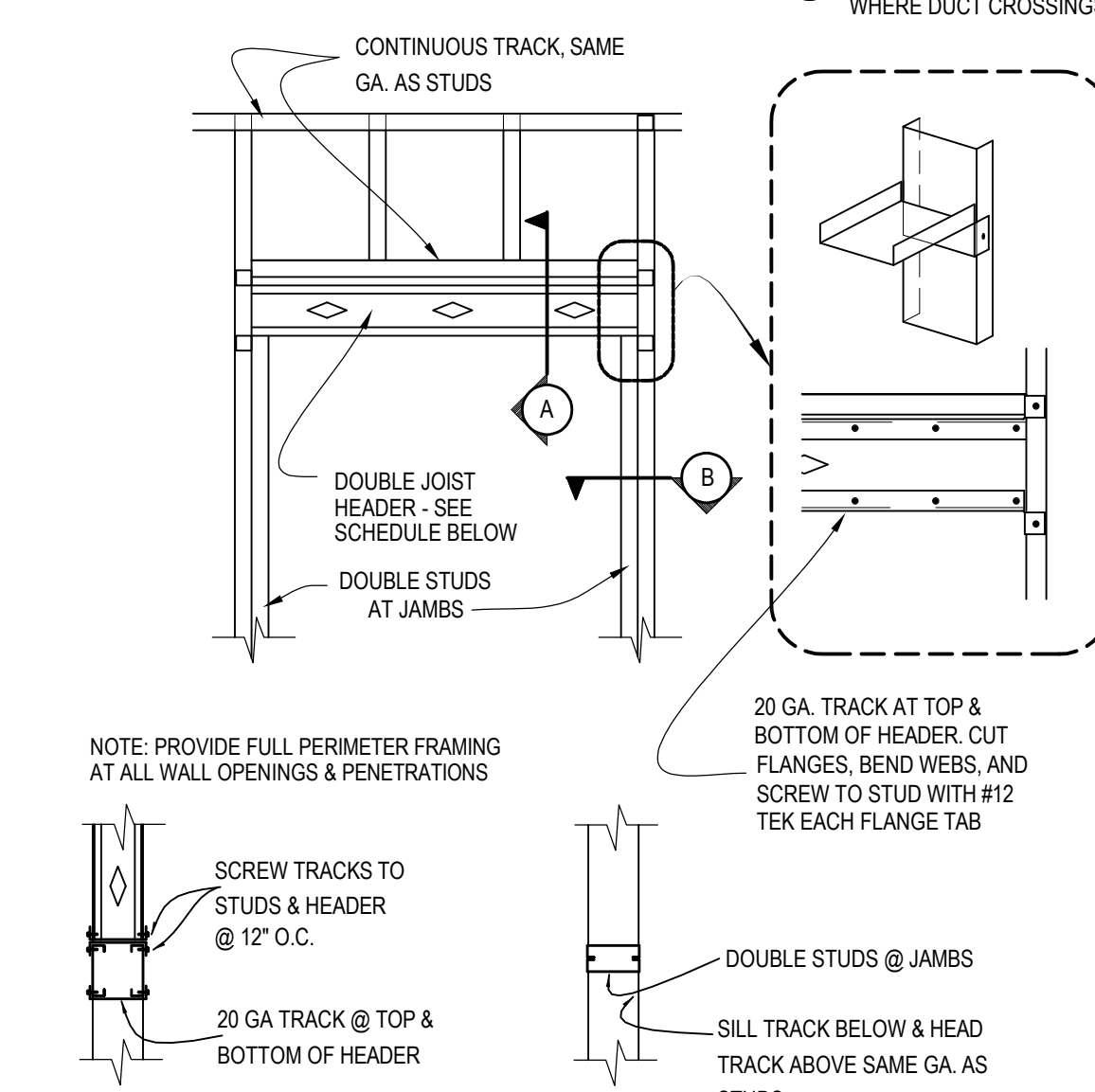
4 WINDOW HEAD DETAIL
A105 SCALE: 1 1/2"=1'-0"



5 WINDOW SILL DETAIL
A105 SCALE: 1 1/2"=1'-0"

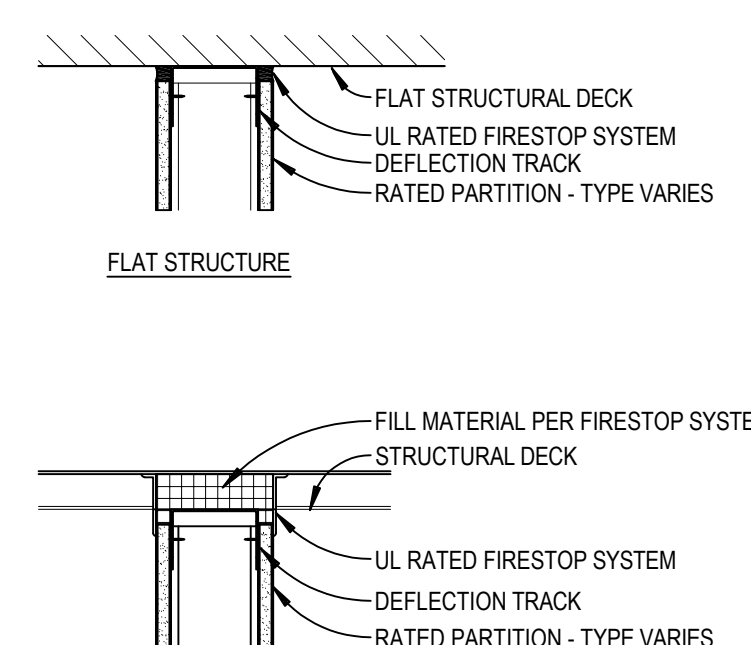


6 TYPICAL WALL BACKING
A105 SCALE: N.T.S.



INTERIOR METAL STUD HEADER SCHEDULE	
HEADER REQ'D.	SPAN
(2)600 E.J. 18 GA PR EQUAL	UP TO 6'-0" SPAN FOR INTERIOR NON-BEARING WALLS
(2)600 E.J. 16 GA PR EQUAL	6'-0" - 8'-6" SPAN FOR INTERIOR NON-BEARING WALLS
(2)600 W.J. 16 GA PR EQUAL	8'-6" - 9'-4" SPAN FOR INTERIOR NON-BEARING WALLS

2 METAL HEADER DETAIL
A105 SCALE: N.T.S.



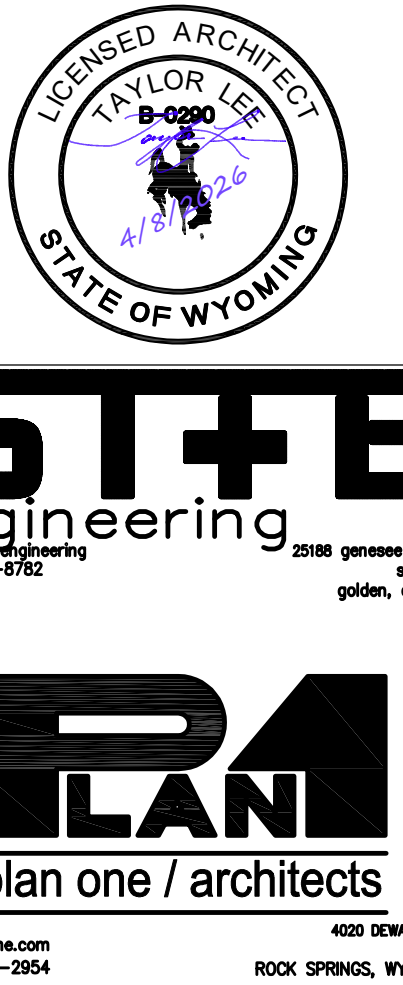
3 TOP OF WALL DETAIL
A105 SCALE: 1 1/2"=1'-0"

GENERAL NOTES:

- REFER TO SHEET A100 FOR ADDITIONAL ARCHITECTURAL GENERAL NOTES THAT PERTAIN TO THIS SHEET. REFER TO G SERIES FOR ADDITIONAL SCOPE OF WORK AND PHASING REQUIREMENTS. LAUNDRY FACILITY TO REMAIN IN OPERATION FOR THE DURATION OF THE PROJECT - COORDINATE WITH OWNER TO CONFIRM PHASING PLANS WITH THE ANTICIPATION OWNER OCCUPANCY.
- REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION, TYPICAL AT ALL.
- SEE SHEETS A100 & A101 FOR WALL TYPES AND RATED ASSEMBLIES.
- SEE PLUMBING AND MECHANICAL PLANS FOR ADDITIONAL SCOPE OF WORK.
- PROVIDE ADDITIONAL SPRINKLER HEADS AS REQUIRED - SEE MECHANICAL/PLUMBING FOR ADDITIONAL INFORMATION.
- SEAL ALL PENETRATIONS AT RATED WALLS.
- GC SHALL REPLACE ANY DAMAGED CEILING TILES TO MATCH (E) AND TOUCH UP/REPLACE ANY DAMAGED CEILING GRID AS OCCURS. TAKE PRECAUTIONS TO NOT LEAVE MARKS FROM TEMPORARY PARTITIONS OR OTHER CONSTRUCTION METHODS.
- SEE SHEETS G001 AND G002 FOR FIRE RATED WALLS AND ADDITIONAL CODE RELATED INFORMATION.

KEYNOTES:

- (E) CEILING GRID TO REMAIN. SALVAGE & REINSTALL CEILING TILES & CEILING DEVICES TO EXTENT REQUIRED TO COMPLETE SCOPE OF WORK ABOVE CEILING - SEE MECH. PLUMB. & ELEC. PLANS FOR SCOPE OF WORK ABOVE CEILING.
- (E) CLEARANCES: 11'-2" BOTTOM OF (E) CAST IN PLACE STRUCTURE, 9'-4" BOTTOM OF (E) SEWER PIPES, 8'-3" BOTTOM OF (E) PIPING - FIELD VERIFY AND COORDINATE NEW SYSTEMS WITH (E) CONDITIONS TO MAINTAIN 8'-0" WORKING CLEARANCES FOR THE ENTIRE ROOM. UNLESS NOTED OTHERWISE.
- PROVIDE INTERIOR PARTITION, EXTENDED TO BOTTOM OF (E) DECK WHERE POSSIBLE. SEE REFLECTED CEILING PLAN AND FLOOR PLAN FOR WALL TYPES - SEE DETAILS 3.9 AND 11A105.
- (E) INSULATED PIPING TO REMAIN - TAKE PRECAUTIONS TO INSTALL NEW DUCT ABOVE, FIELD VERIFY AND SIZE DUCT TO FIT WITHIN (E) CONDITIONS.
- REMOVE (E) GLAZING PANEL AND REPLACE WITH INSULATED PANEL - COORDINATE WITH MECHANICAL FOR EMBEDDED LOUVER INSTALLATION AND DETAILS THIS SHEET.
- REMOVE (E) ELECTRICAL DEVICES, LIGHTS, AND MECHANICAL DEVICES TO EXTENTS REQUIRED FOR NEW SCOPE OF WORK - SEE MECHANICAL, ELECTRICAL, AND PLUMBING.
- (E) ROOMS, N/C. UNLESS NOTED OTHERWISE - SEE MECHANICAL & ELECTRICAL.
- REMOVE TACK BOARD AND WINDOW INFILL TO EXTENTS REQUIRED TO PROVIDE NON-COMBUSTIBLE CONSTRUCTION. PROVIDE 5/8" TYPE X GWB EA SIDE OF METAL STUDS @ 16" O.C. FLUSH FINISH TO FACE OF FRAME, SIM. TO WALL TYPE A1.
- REMOVE (E) CMU WALL PARTITION FROM BOTTOM OF STRUCTURE ABOVE TO BOTTOM OF NEW DUCT/PIPPING TO EXTENTS REQUIRED TO INSTALL NEW EQUIPMENT - PROVIDE METAL STUD INFILL, SIM. TO WALL TYPE A1 WHERE GAP OCCURS WITHIN STRUCTURAL CONCRETE BAYS EXCEEDING ALLOWABLE INFILL BY FIREPROOFING MANUFACTURER - SEE SPECIFICATIONS AND MECHANICAL.
- (E) DUCT ABOVE, PROVIDE SOFFIT AS INDICATED - SEE SHEET A102 AND MECHANICAL.
- (E) SLAB ON GRADE TO REMAIN - SEE SHEET A101 FOR FLOOR FINISHES.
- INSULATED METAL DUCT PER MECHANICAL - TAKE PRECAUTION WITH EXISTING CONDITIONS. FIELD VERIFY AND COORDINATE FINAL ROUTING AND SIZING WITH EXISTING CONDITIONS PRIOR TO FABRICATION. KEEP HIGH AND TIGHT AS REQUIRED PER MECHANICAL TAKING NOTE OF EXISTING BEAMS AND UTILITIES THAT ARE NOT ABLE TO BE RELOCATED.
- LINEN DRYER EQUIPMENT - SEE MECHANICAL AND PLUMBING.
- PANEL CEILING IN EXPOSED T-GRID - SEE SHEET A102.
- REMOVE AND REPLACE (E) FLOOR EXPANSION JOINT - PROVIDE COVER PER DETAIL 7A105.
- PROVIDE DROPPED CEILING TILE INSTALLATION WITH VERTICAL TRUNTINGS WHERE DUCT CROSSINGS OCCUR AT EXISTING BEAM - SEE SHEET A102.



MEMORIAL HOSPITAL OF SWEETWATER COUNTRY LAUNDRY RENOVATION 1200 COLLEGE DRIVE ROCK SPRINGS, WYOMING

Project No.:	2645.24
Plan One / Architects Project No.:	2602
SUBMISSION	DATE
PRELIMINARY REVIEW	2/12/2026
PERMIT	4/8/2026
ISSUE FOR BID	6/11/2026

ARCHITECTURAL
BASEMENT BUILDING
SECTIONS & DETAILS

Sheet No. A105

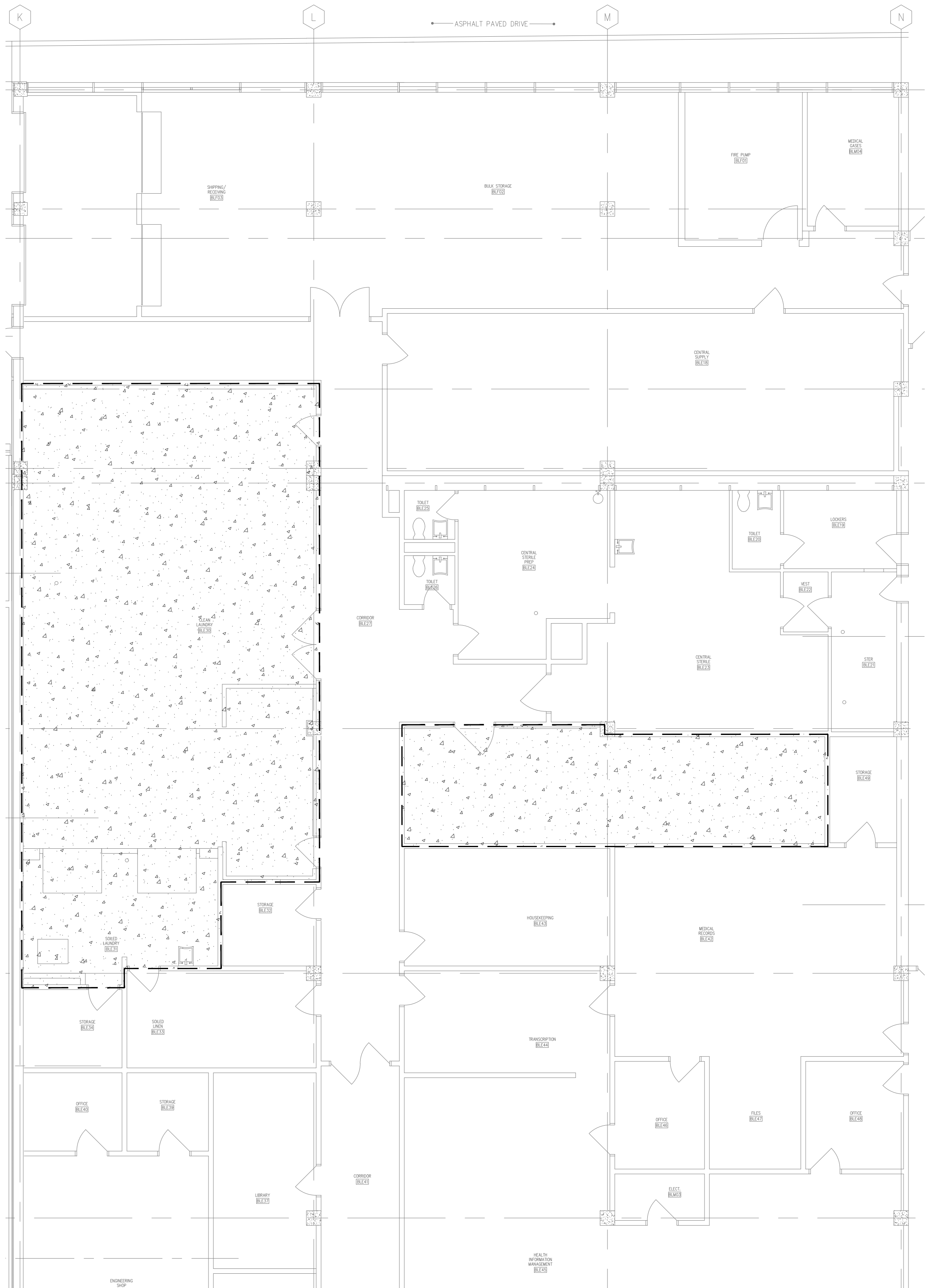
2024.02 2:18pm STB Projects\36-4-24 - HHSB - Laundry Renovation\4201.DWG\Rev01\FP000_Legend.dwg 4/8/2025 3:19 PM

FIRE PROTECTION CRITERIA:

	LIGHT HAZARD (0.10 GPM / SF, 225 SF / SPRINKLER, 100 GPM HOSE ALLOWANCE)
	ORDINARY GROUP 1 HAZARD (0.15 GPM / SF, 130 SF / SPRINKLER, 250 GPM HOSE ALLOWANCE)
	ORDINARY GROUP 2 HAZARD (0.20 GPM / SF, 130 SF / SPRINKLER, 250 GPM HOSE ALLOWANCE)
	LIGHT HAZARD (DRY HEADS) (0.10 GPM / SF, 225 SF / SPRINKLER, 100 GPM HOSE ALLOWANCE)
	EXTRA HAZARD 2 (0.40 GPM / SF, 100 SF / SPRINKLER, 500 GPM HOSE ALLOWANCE)

DESIGN PARAMETERS:

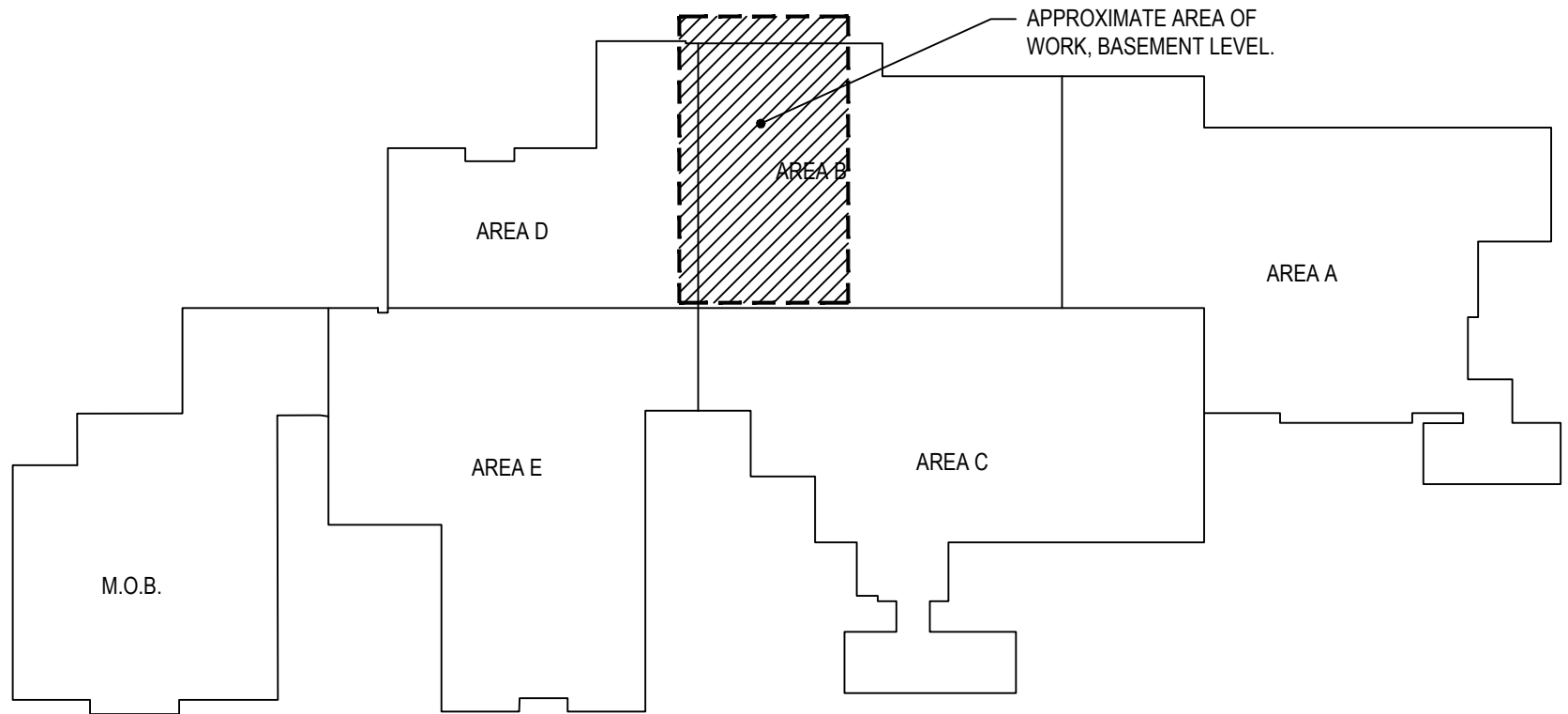
- OCCUPANCY CLASSIFICATIONS:
 - AS INDICATED ON CRITERIA PLANS
- DENSITY:
 - LIGHT HAZARD - 0.10 GPM / 1,500 SF (100 GPM HOSE ALLOWANCE)
 - ORDINARY GROUP I HAZARD - 0.15 GPM / 1,500 SF (250 GPM HOSE ALLOWANCE)
 - ORDINARY GROUP II HAZARD - 0.20 GPM / 1,500 SF (250 GPM HOSE ALLOWANCE)
 - EXTRA HAZARD I - 0.30 GPM / 2,500 SF (500 GPM HOSE ALLOWANCE)
 - EXTRA HAZARD II - 0.40 GPM / 2,500 SF (500 GPM HOSE ALLOWANCE)
- COVERAGE:
 - LIGHT HAZARD - 225 SF / SPRINKLER (15' MAXIMUM ALLOWABLE SPACING)
 - ORDINARY HAZARD - 130 SF / SPRINKLER (15' MAXIMUM ALLOWABLE SPACING, HOWEVER, BASIS OF DESIGN PIPING SHALL BE 10' X 12' MAXIMUM)
 - EXTRA HAZARD - 100 SF / SPRINKLER (12' MAXIMUM ALLOWABLE SPACING, HOWEVER, BASIS OF DESIGN PIPING SHALL BE 10' X 10' MAXIMUM)



1
FP000
FIRE PROTECTION CRITERIA PLAN
SCALE: 1/8" = 1'-0"
0 5 10'

GENERAL NOTES:

- DO NOT SCALE DRAWINGS. VERIFY DIMENSIONS PRIOR TO COMMENCEMENT OF WORK. REFER TO ARCHITECTURAL DRAWINGS FOR ALL DIMENSIONS.
- THESE DRAWINGS ARE NECESSARILY DIAGRAMMATIC IN NATURE. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING AND INCLUDE ALL SPRINKLER HEADS AND PIPING AS REQUIRED TO PROVIDE A COMPLETE AND FUNCTIONING SYSTEM. SPRINKLER HEAD LOCATIONS AND BASIC PIPING DEPICTIONS PROVIDED TO DEPICT DESIGN INTENT, AND SHALL NOT BE CONSTRUED AS EXACT HEAD PLACEMENT OR PIPE ROUTING CRITERIA. INFORMATION PROVIDED TO REPRESENT DESIGN INTENT. FIRE PROTECTION CONTRACTOR SHALL BE RESPONSIBLE TO GENERATE DETAILED SHOP DRAWING, INCLUDING EXACT PIPING ROUTING COORDINATED WITH BUILDING ARCHITECTURE, STRUCTURE AND INFRASTRUCTURE AS WELL AS HYDRAULIC CALCULATIONS.
- PIPE SCHEDULE DESIGN METHODS ARE NOT PERMITTED. HYDRAULIC CALCULATIONS MUST BE PERFORMED TO ALL APPLICABLE NFPA SPECIFICATIONS AND SUBMITTED TO THE ARCHITECT/ENGINEER FOR APPROVAL AS PART OF THE SHOP DRAWING PROCEDURE. PROVIDE DRAWINGS AND CALCULATIONS WITH SEAL OF LICENSED FIRE PROTECTION ENGINEER OR NECTI III LEVEL TECHNICIAN FOR SUBMITTAL TO FIRE MARSHAL PRIOR TO INSTALLATION.
- PROVIDE ELECTRONIC (PDF) DRAWINGS AND CALCULATIONS WITH PROFESSIONAL ENGINEER'S OR NECTI CERTIFIED DESIGNER'S SEAL FOR SUBMITTAL TO STATE FIRE MARSHAL'S OFFICE FOR REVIEW PRIOR TO INSTALLATION. PROVIDE ELECTRONIC COPIES OF SHOP DRAWINGS, CALCULATIONS AND EQUIPMENT SUBMITTALS WITH PROFESSIONAL ENGINEER'S OR NECTI CERTIFIED DESIGNER'S SEAL FOR SUBMITTAL TO GENERAL CONTRACTOR FOR REVIEW AND SUBSEQUENT SUBMITTAL BY GENERAL CONTRACTOR TO DESIGN TEAM AND AUTHORITY HAVING JURISDICTION FOR REVIEW.
- SEE SPECIFICATIONS AND ARCHITECTURAL SHEETS FOR CONSTRUCTION PHASING REQUIREMENTS. DURING EACH PHASE, AS MUCH WORK AS POSSIBLE MUST BE PERFORMED WITHIN THE BOUNDARIES OF THAT PHASE.
- ALL NEW SPRINKLER HEADS SHALL BE QUICK RESPONSE TYPE.
- ADJACENT SPRINKLERS SHALL NOT BE PLACED CLOSER THAN 8' TO ONE ANOTHER, UNLESS SPECIFICALLY NOTED OTHERWISE. CODE ALLOWABLE MINIMUM DISTANCES ARE SMALLER BUT SHALL REQUIRE APPROVAL PRIOR TO INSTALLATION.
- PIPING SHALL NOT BE INSTALLED ABOVE ELECTRIC EQUIPMENT / PANELS AND SHALL NOT BE ROUTED THROUGH ELECTRICAL SPACES EXCEPT AS REQUIRED TO PROVIDE PROTECTION FOR THE ROOM. PLACE SPRINKLER HEAD(S) AND ROUTE PIPING IN A MANNER TO MINIMIZE PIPING WITHIN THE SPACE.
- ALL PIPING SHALL BE INSTALLED AS HIGH AS POSSIBLE. PROVIDE VENTS AT ALL HIGH POINTS IN THE PIPING SYSTEM WITH THE EXCEPTION OF ARM-OVERS SERVING A SINGLE SPRINKLER HEAD.
- PROVIDE DRAINS AT ALL LOW POINTS IN THE PIPING SYSTEM. PROVIDE REMOVER CONNECTION TO ALL INDIVIDUAL SPRINKLERS. MAXIMUM AMOUNT OF VOLUME THAT CAN BE DRAINED FROM REMOVAL OF ANY SINGLE SPRINKLER HEAD SHALL NOT EXCEED 5 GALLONS. VOLUME DRAINED FROM ANY SINGLE VALVED LOW POINT SHALL NOT EXCEED 35 GALLONS. ANY VALVED DRAINS CONTAINING MORE THAN 35 GALLONS SHALL BE PIPED TO THE EXTERIOR OF THE BUILDING.
- PROVIDE ALL FITTINGS, RISER NIPPLES, ARM-OVERS, HANGERS, ETC TO MAINTAIN CONFORMANCE WITH APPLICABLE STANDARDS AND TO POSITION THE SPRINKLER HEADS IN THEIR PROPER LOCATIONS. FLEXIBLE SPRINKLER FITTING SYSTEMS IN LIEU OF HARD PIPED ARM OVER ASSEMBLIES ARE ACCEPTABLE.
- SEE ARCHITECTURAL REFLECTED CEILING PLAN FOR RCP SYMBOL LIST AND FOR GUIDELINES FOR PLACEMENT OF SPRINKLER HEADS IN CEILING PANELS.
- THE REFLECTED CEILING PLANS (RCP'S) SHOWN IN THESE DRAWING BACKGROUND ARE PROVIDED FOR REFERENCE ONLY AND REFLECT ANTICIPATED PLACEMENT OF NON-FIRE SPRINKLER SYSTEM COMPONENTS SUCH AS HVAC REGISTERS, LIGHTING, SPEAKERS, NURSE CALL SYSTEMS, FIRE ALARM COMPONENTS, ETC. REFER TO ARCHITECTURAL RCP'S AS WELL AS RCP'S OF OTHER DIVISIONS (IE LIGHTING, ETC) DURING THE SHOP DRAWING COORDINATION PROCESS. IMMEDIATELY NOTIFY ARCHITECT AND ENGINEER IN THE EVENT OF DISCREPANCY BETWEEN THE DIVISIONS.
- SPRINKLER HEADS SHOWN ON THESE PLANS ARE INTENDED TO SHOW COORDINATION BETWEEN THIS AND OTHER TRADES. OMISSION OF SUCH HEADS NOT SHOWN ON THIS PLAN, REQUIRED BY CODE, SHALL NOT RELIEVE THE FIRE PROTECTION CONTRACTOR FROM PROVIDING THEM UNDER THIS CONTRACT.
- COORDINATION OF ALL MEP SYSTEMS ABOVE CEILINGS (LIGHTING, DUCTWORK, DIFFUSERS, PIPING, ELECTRICAL, FIRE PROTECTION, ETC) MUST BE COMPLETED BY THIS CONTRACTOR PRIOR TO ANY INSTALLATIONS. CONTRACTOR SHALL SUBMIT 1/4" SCALE COORDINATION SHOP DRAWINGS ON ARCHITECTURAL BACKGROUNDS SHOWING ALL SYSTEMS TO BE COORDINATED. REFERENCE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
- FIRE PROTECTION CONTRACTOR SHALL COORDINATE ALL FIRE PROTECTION WORK WITH ALL DUCTWORK AND OTHER TRADES PRIOR TO COMMENCEMENT OF WORK SO AS NOT TO INTERFERE WITH ROUTING AND INSTALLATION OF NEW OR EXISTING PIPING/DUCTWORK, ELECTRICAL RACEWAY, LIGHTING AND ANY OTHER SYSTEMS OCCUPYING THE SPACE IN THE CEILING OR ABOVE THE CEILING PLANE.
- FINAL SPRINKLER HEAD LAYOUTS SHALL BE COORDINATED WITH AS BUILT CONDITIONS FOR ALL DISCIPLINES / TRADEWORK. ADDITIONAL SPRINKLER SHALL BE PROVIDED AS REQUIRED DUE TO ADDITIONAL OBSTRUCTIONS SUCH AS DUCT LAYOUTS.
- THE BUILDING SPRINKLER SYSTEM SHALL BE DESIGNED, INSTALLED AND TESTED FOR PROTECTION THROUGHOUT IN ACCORDANCE WITH NFPA 13.
- SYSTEM AND COMPONENTS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH NFPA 13 AND NFPA 14, LOCAL BUILDING CODES AND ORDINANCES, FM AND UL APPROVALS AND THE DIVISION 21 SPECIFICATIONS FOR THE PROJECT. INSTALLATION SHALL MEET THE REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION AND THE OWNER'S INSURING AGENCY. IN THE EVENT OF CONFLICT BETWEEN THESE REQUIREMENTS, ASSUME THE MOST STRINGENT REQUIREMENT SHALL APPLY FOR PRICING PURPOSES AND CONSULT THE ENGINEER FOR DIRECTION.
- THIS CONTRACTOR SHALL VERIFY THE EXISTING CONDITIONS AT THE PROJECT SITE BEFORE SUBMITTING COST PROPOSAL. CONTRACTOR IS ADVISED THAT ALL LOCATIONS ARE APPROXIMATE.
- IT IS MANDATORY THAT EXISTING BUILDINGS REMAIN IN CONTINUOUS AND NON-INTERRUPTED OPERATION DURING REMODELING/ALTERING OF THE EXISTING BUILDING THE SPECIFIC AREA(S) BEING REMODELED/ALTERED AT ANY SCHEDULED TIME ARE OBVIOUSLY EXCLUSIVE OF THIS STATEMENT. SERVICES TO EXISTING BUILDING SHALL BE KEPT ON CONTINUOUS OPERATION INCLUDING FIRE-SPRINKLER PIPING. ANY ABSOLUTELY NECESSARY INTERRUPTION OF THESE SERVICES TO ACCOMPLISH PROJECT CONSTRUCTION, SHALL BE ARRANGED WITH THE OWNER THROUGH THE GENERAL CONTRACTOR, A MINIMUM OF TWO (2) WEEKS IN ADVANCE. TEMPORARY SERVICES SHALL BE FURNISHED WHERE NECESSARY TO ACCOMPLISH THIS PURPOSE. TEMPORARIES SHALL BE REMOVED ONLY AFTER NEW PERMANENT SERVICES ARE INSTALLED AND FULLY OPERATIONAL.
- THIS CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN DEMOLITION, REMOVAL, CAPPING, STORING, ABANDONING, DISCONNECTING, RELOCATING AND RECONNECTION OF EXISTING EQUIPMENT AND MATERIAL. ALL CUTTING, PATCHING, REPAIRING, REPLACEMENT AND REFINISHING, SHALL MATCH THE EXISTING CONSTRUCTION AS NEARLY AS POSSIBLE.
 - INCLUDE IN BID THE COSTS TO REMOVE ALL EXISTING FIRE SPRINKLER HEADS AND PIPING THROUGHOUT THE RENOVATED SPACE. INCLUDE COMPLETELY NEW SPRINKLER PIPING THROUGHOUT IN ORDER TO COORDINATE WITH THE NEW ABOVE CEILING SYSTEMS.
 - REMOVE ALL SPRINKLER HEADS AND SPRINKLER PIPING. CAP AT NEAREST ACTIVE MAIN. SUPPLY AND RETURN MAINS TO BE VALVED AND CAPPED.
 - IN REMODELED / ALTERED AREAS ANY PIPING PASSING THROUGH THE REMODELED AREAS TO SERVE (OR BEING SERVED FROM EXISTING ADJACENT, REMOTE, OR SURROUNDING AREA THAT ARE TO REMAIN) SHALL BE RETAINED AND KEPT OPERATIONAL, AND SHALL BE REROUTED IN ALL CASES WHERE THEY INTERFERE WITH ANY NEW WORK OR USAGE TO BE ACCOMPLISHED IN THE REMODELED AREA.
 - PENETRATIONS THROUGH EXISTING WALLS AND FLOORS FORMERLY OCCUPIED BY REMOVED PIPING SHALL BE PATCHED TO MATCH EXISTING CONSTRUCTION.
- THIS CONTRACTOR SHALL REFER TO ARCHITECTURAL DRAWINGS TO FAMILIARIZE THEMSELVES WITH EXTENT OF ALTERATION / REMODELING WORK AND MORE SPECIFICALLY NOTE WHERE NEW PARTITIONING IS BEING INSTALLED, WHERE EXISTING PARTITIONING IS BEING REMOVED, WHERE CEILINGS ARE BEING REMOVED AND OR REPLACED, ETC.
- ALL NEW SPRINKLERS SHALL MATCH THE EXISTING TO REMAIN IN PLACE SPRINKLERS (QUICK RESPONSE OR STANDARD RESPONSE) WHEN INSTALLED WITHIN THE SAME ROOM. ALL OTHER NEW SPRINKLER HEADS SHALL BE QUICK RESPONSE TYPE.
- UPON REMOVAL OF EXISTING CEILING DURING DEMO PHASE OF CONSTRUCTION, EXTEND EXISTING PIPING AND REPLACE EXISTING PENDENT SPRINKLER HEADS WITH TEMPORARY UPRIGHT HEADS, RELOCATED AND SUPPLEMENTED AS NECESSARY TO MAINTAIN COMPLETE COVERAGE PER NFPA 13 DURING CONSTRUCTION RENOVATION PHASE.
- MAINTAIN CONTINUITY OF FIRE SPRINKLER SERVICE AND COVERAGE DURING THE ENTIRE PROJECT DURATION. BE RESPONSIBLE TO COORDINATE SERVICE INTERRUPTIONS AND FIRE WATCH REQUIREMENTS WITH THE GENERAL CONTRACTOR, OWNER AND AUTHORITY HAVING JURISDICTION. ANTICIPATE TEMPORARY PIPING WILL BE REQUIRED DURING THE PROJECT TO FACILITATE REMOVAL OF EXISTING COVERAGE PRIOR TO INSTALLATION OF NEW COVERAGE.
- SPRINKLERS SHALL BE DEMOLISHED FROM EXISTING SPACES / CEILING (TYP). REFERENCE ARCHITECTURAL DRAWINGS FOR EXTENT OF DEMOLITION SCOPE OR WORK. SPRINKLER PIPING / ARM-OVERS SHALL BE CAP AT THE SPRINKLER MAIN / BRANCH PIPING. SPRINKLER PIPING / ARM-OVERS SHALL BE CAP AT THE SPRINKLER MAIN / BRANCH PIPING. NEW SPRINKLERS AND NECESSARY PIPING SHALL BE PROVIDED IN THE SPACES INDICATED ON PLANS AND CONNECTED TO EXISTING MAIN / BRANCH PIPING. EXISTING IN PLACE SPRINKLERS MAY BE REUSED PROVIDED THEY FULLY FUNCTIONAL AND NOT DAMAGED DURING DEMOLISHING SCOPE OF PROJECT. CONTRACTOR SHALL NOT REUSE ANY SPRINKLERS THAT ARE REMOVED / DEMOLISHED.
- AN ATTEMPT HAS BEEN MADE TO SHOW ALL SPRINKLER HEADS, BUT SYSTEM PIPING IS CURRENTLY NOT SHOWN. THIS CONTRACTOR SHALL VISIT THE SITE TO VERIFY COMPONENTS, LOCATIONS AND SIZES SHOWN OR NOT SHOWN. ALL COMPONENTS NEED TO BE REMOVED IN THE DEMOLITION AREA UNLESS NOTED ON THE DRAWINGS.



KEY PLAN

PLAN SYMBOLS LEGEND

PLAN	DESCRIPTION
	DRAWING KEYNOTE
	DEMOLITION DRAWING KEYNOTE
	REVISION CLOUD TAG
	SYSTEM DISCONNECT SYMBOL
	SYSTEM NEW CONNECTION SYMBOL
	MECHANICAL EQUIPMENT CALLOUT
	MISC./OWNER EQUIPMENT CALLOUT
	MEDICAL EQUIPMENT CALLOUT
	ELEVATION/SECTION CALLOUT

SPRINKLER HEAD LEGEND

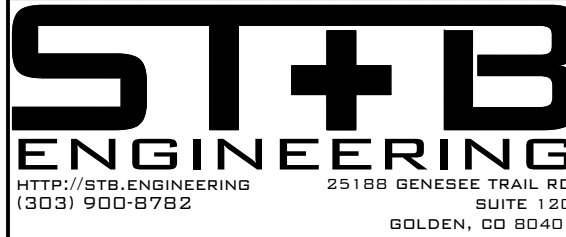
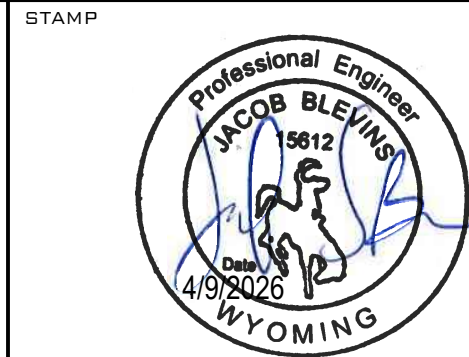
PLAN	DESCRIPTION
	CONCEALED PENDENT SPRINKLER HEAD
	DRY PENDENT SPRINKLER HEAD
	EXPOSED PENDENT SPRINKLER HEAD
	INSTITUTIONAL PENDENT SPRINKLER HEAD
	SEMI-RECESSED PENDENT SPRINKLER HEAD
	UPRIGHT SPRINKLER HEAD
	CONCEALED SIDEWALL SPRINKLER HEAD
	DRY SIDEWALL SPRINKLER HEAD
	SIDEWALL SPRINKLER HEAD

FIRE PROTECTION ABBREVIATIONS

ADA	AMERICANS WITH DISABILITIES ACT
AFAT	AMP FRAME, AMP TRIP
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AIC	AMPIERES INTERRUPTING CAPACITY (SYMMETRICAL)
AMP or A	AMPERE
ASIAF	AMP SWITCH, AMP FUSE
ATS	AUTOMATIC TRANSFER SWITCH
AVG	AVERAGE
AWG	AMERICAN WIRE GAUGE
BAS	BUILDING AUTOMATION SYSTEM
BFG	BELOW FINISHED GRADE
C	CONDUIT
CB	CIRCUIT BREAKER
CIRC. CKT	CIRCUIT
CT	CURRENT TRANSFORMER
(D) or DEMO	DEMOLISH
DISC	DISCONNECT
(E)	EXISTING
EF	EXHAUST FAN
EMT	ELECTRICAL METALLIC TUBING
ENT	ELECTRICAL NON-METALLIC TUBING
EPO	EMERGENCY POWER OFF
(F)	FUTURE
FA	FIRE ALARM
FCT	FOR CONTINUATION
FFI	FOR FURTHER INFORMATION
FLA	FULL LOAD AMPS
FSD	FIRE SMOKE DAMPER
FT or ' "	FEET
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GRD	GROUND
WD, H, L	WIDTH, DEPTH, HEIGHT, LENGTH
HDA	HAND-OFF-CUT
HP	HORSEPOWER
HVAC	HEATING, VENTILATION, AND AIR CONDITIONING
IG	ISOLATED GROUND
IN or ' "	INCHES
JBOX	JUNCTION BOX
KVA	KILOVOLT AMPERES
KW	KILOWATT
KWH	KILOWATT HOUR
LF	LINEAR FEET
LTG or LFS	LIGHTING
M	METER
MAX	MAXIMUM
MCA	MINIMUM CIRCUIT AMPACITY
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCN	THOUSAND CIRCULAR MILS
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MLO	MAIN LUGS ONLY
MOCF	MAXIMUM OVERCURRENT PROTECTION
MON	MONITORING
MTD	MOUNTED
(N)	NEW
NC / NO	NORMALLY CLOSED / NORMALLY OPEN
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NF	NON-FUSED
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
No. or #	NUMBER
NTS	NOT TO SCALE
OFO	OWNER, FURNISHED, CONTRACTOR INSTALLED
P	POLE
PC	PHOTOCELL
PH	PHASE
PROVIDE	FURNISH AND INSTALL
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE
(R)	RELOCATED
RE	REFER TO
REC or RECEPT	RECEPTACLE
RGS	RIGID GALVANIZED STEEL
RMS	ROOT MEAN SQUARE
SF	SQUARE FEET
SPD	SURGE PROTECTION DEVICE
SPST	SINGLE-POLE, SINGLE-THROW
SQ	SQUARE
TC	TIMECLOCK
TEL/DATA	TELEPHONE/DATA
TV	TELEVISION
TYP	TYPICAL
UGPS	UNDERGROUND PULL SECTION
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SYSTEM
V	VOLTS
VA	VOLT AMPERES
VAV	VARIABLE AIR VOLUME
VD	VOLTAGE DROP
VFD	VARIABLE FREQUENCY DRIVE
W	WIRE
W	WITH
WP	WEATHERPROOF
XFRM	TRANSFORMER
%Z	PERCENTAGE IMPEDANCE

SHEET INDEX - FIRE PROTECTION

DELIVERABLE KEY:		DELIVERABLE	
ISSUED		HLS MINOR PROJECTS SUBMITTAL - 02/14/25 PERMIT - 04/09/26	
DISCONTINUED			
REFERENCE ONLY			
NUMBER	NAME		
FP000	FIRE PROTECTION NOTES, LEGENDS, & CRITERIA PLAN		
FP100	PARTIAL LOWER LEVEL LAUNDRY FIRE PROTECTION DEMOLITION PLAN		
FP200	PARTIAL LOWER LEVEL LAUNDRY FIRE PROTECTION NEW WORK PLAN		



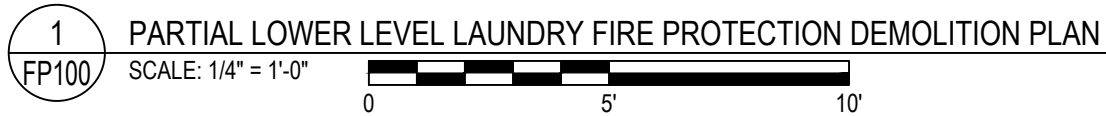
MEMORIAL HOSPITAL OF
SWEETWATER COUNTRY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

ST+B PROJECT NO.: 2645.24

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	01/1/2025

SHEET NAME
FIRE PROTECTION
LEGEND, NOTES &
CRITERIA PLAN

SHEET NO.
FP000



KEYNOTES:

- 1 DISCONNECT FIRE BRANCH & PREPARE TO LOWER AND ROUTE BELOW OA DUCT AND RECONNECT, TYP 5.
- 2 REMOVE SPRINKLER BRANCH AND RE-ROUTE TO NOT PASS WE SPRINKLER PIPING THROUGH NEW DRYER PLENUM.



ST+B PROJECT NO.:	2645.24

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SHEET NO. _____

FP 100



SHEET NO.

FP200

2024.02 2:18:08 PM 36-45-2-24 - 04-02 - Laundry Renovation 4202.DWG (MFD) - LEGEND

- PRELIMINARY TESTING (PRE-TAB) NOTES:**
- THE PROJECT CONSISTS OF MODIFICATION, EXTENSION, REPLACEMENT AND/OR RE-USE OF EXISTING HVAC SYSTEMS. PRIOR TO ANY DEMOLITION PRESCRIBED HEREIN, A PRELIMINARY TAB EXERCISE SHALL BE PERFORMED TO DETERMINE EXISTING CONDITIONS THAT CANNOT OTHERWISE BE VERIFIED THROUGH SIMPLE VISUAL INSPECTION. REFER TO SECTION 23.0953 - TESTING, ADJUSTING, AND BALANCING FOR DETAILED INFORMATION REGARDING PROCEDURES AND PROTOCOLS SPECIFIC TO THE TYPE OF EQUIPMENT REQUIRING PRELIMINARY TAB EXERCISE.
 - THE FIELD PORTION OF THE PRE-TAB EXERCISE SHALL CONSIST OF THE TESTING COMPONENT ONLY, AS SPECIFIED IN SECTION 23.0953 - TESTING, ADJUSTING AND BALANCING. ADJUSTMENT AND BALANCING OF EXISTING SYSTEMS ARE NOT REQUIRED AS PART OF THE PRE-TAB SCOPE. UPON COMPLETION OF THE FIELD PORTION OF PRE-TAB EXERCISE, COMPLETE AND SUBMIT TO ENGINEER FOR REVIEW A CERTIFIED TAB REPORT OF ALL TESTS AND MEASUREMENTS TAKEN.
 - SYSTEMS TO BE INVESTIGATED DURING PRE-TAB EXERCISE:

- A. SYSTEM WATER FLOW (GPM) AND PRESSURE DROP (FT WG OR PSI) AT ALL HYDRONIC TERMINAL DEVICES WITHIN THE RENOVATION SPACE.
- B. AIRFLOW (CFM) AT ALL SUPPLY, RETURN, AND EXHAUST REGISTERS WITHIN THE RENOVATION SPACE.
- C. PERFORMANCE OF SYSTEMS SERVING THE RENOVATION SPACE SUCH AS VAV BOXES, MAKE-UP AIR UNITS, EXHAUST FANS, ETC PROVIDING HVAC SERVICE TO THE RENOVATION SPACE. MEASURE TOTAL CFM, AIR PRESSURE, AND MOTOR PARAMETERS (RPM, 1/2 IF VFD, RLA, ETC AS SPECIFIED IN 23.0953). PROVIDE FAN MANUFACTURER'S DATA SHEETS AS WELL AS NAMEPLATE DATA SUCH AS MOTOR FLA.
- D. PERFORMANCE OF COILS PROVIDING HYDRONIC SERVICE (HEATING, CHILLED, CONDENSER WATER, ETC) TO THE RENOVATION SPACE. MEASURE TOTAL GPM, AND DISCHARGE WATER PRESSURE.

- GENERAL MECHANICAL HVAC NOTES:**
- THIS SHEET IS PART OF A COMPREHENSIVE SET OF DESIGN DRAWINGS AND SPECIFICATIONS THAT INCLUDE OTHER ENGINEERING, ARCHITECTURAL, AND DESIGN DISCIPLINES. THIS CONTRACTOR IS RESPONSIBLE FOR THE REVIEW OF ALL OTHER DISCIPLINE'S SHEETS AND ALL OTHER DISCIPLINES' SPECIFICATIONS IN CONJUNCTION WITH THIS SHEET AND ITS ASSOCIATED DISCIPLINE REGARDLESS OF THIS CONTRACTOR'S RESPECTIVE DISCIPLINE. CONTRACTOR BEARS THE RESPONSIBILITY FOR LACK OF INTERDISCIPLINARY COORDINATION.
 - THIS CONTRACTOR SHALL VERIFY THE EXISTING CONDITIONS AT THE PROJECT SITE BEFORE SUBMITTING COST PROPOSAL. BE ADVISED THAT ALL LOCATIONS ARE APPROXIMATE.
 - DO NOT SCALE DRAWINGS. VERIFY DIMENSIONS PRIOR TO COMMENCEMENT OF WORK. REFER TO ARCHITECTURAL DRAWINGS FOR ALL DIMENSIONS.
 - THESE DRAWINGS ARE NECESSARILY DIAGRAMMATIC IN NATURE. NOT ALL FITTINGS, OFFSETS, AND SLOPES ARE SHOWN. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING AND INCLUDE ALL FITTINGS, OFFSETS, AND SLOPES AS REQUIRED TO PROVIDE A COMPLETE AND FUNCTIONING SYSTEM.
 - COORDINATION OF ALL MEP SYSTEMS ABOVE CEILINGS (LIGHTING, DUCTWORK, DIFFUSERS, PIPING, ELECTRICAL, FIRE PROTECTION, ETC.) MUST BE COMPLETED BY THIS CONTRACTOR PRIOR TO ANY INSTALLATIONS. CONTRACTOR SHALL SUBMIT 1/4" SCALE COORDINATION SHOP DRAWINGS ON ARCHITECTURAL BACKGROUNDS SHOWING ALL SYSTEMS TO BE COORDINATED. REFERENCE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
 - ALL DUCT CONNECTIONS TO RETURN AND EXHAUST GRILLES REGISTERS AND DIFFUSERS (GRDS) SHALL BE MADE WITH HARD PIPE. FLEXIBLE CONNECTION NOT PERMITTED. ACOUSTIC FLEX 4' MAX LENGTH PERMITTED FOR SUPPLY GRDS ONLY.
 - RETURN AIR AND EXHAUST AIR DUCTS SHALL BE PROVIDED WITH RADIUS ELBOWS. MITERED ELBOWS WITH TURNING VANES SHALL BE AVOIDED. IF MITERED ELBOWS ARE UNAVOIDABLE, PROVIDE ACCESS DOORS UPSTREAM AND DOWNSTREAM OF FITTING FOR CLEANING OF TURNING VANES.
 - AN ATTEMPT HAS BEEN MADE TO SHOW ALL DUCTWORK, AIR DEVICES, AND BALANCING DAMPERS. THIS CONTRACTOR SHALL VISIT THE SITE TO VERIFY COMPONENTS, LOCATIONS, AND SIZES SHOWN OR NOT SHOWN. ALL HATCHED COMPONENTS SHALL BE REMOVED IN THE DEMOLITION AREA UNLESS NOTED ON THE DRAWINGS.
 - ALL BRANCH DUCTING TO AIR DEVICES SHALL BE PROVIDED WITH A BALANCING DAMPER WHETHER SHOWN IN THE PLANS OR NOT.
 - ALL DUCTWORK MAINS SHALL BE INSTALLED AS HIGH AS POSSIBLE. BRANCH DUCTWORK BALANCE DAMPERS AND TERMINAL DEVICES SHALL BE LOW ENOUGH TO BE ACCESSIBLE FROM CEILING ACCESS PANELS OR LAY-IN CEILING PANELS.
 - WHEN ROUTING DUCTWORK UTILIZE JOIST SPACING WHEN POSSIBLE, ESPECIALLY WHEN CROSSING OTHER DUCTS, PIPES, OR ELECTRICAL.
 - DUCTWORK SHALL NOT BE INSTALLED IN OR ABOVE ELECTRIC ROOMS OR ELECTRICAL EQUIPMENT UNLESS OTHERWISE NOTED.

- ACCESS PANELS SHALL BE 24/24 UNLESS NOTED OTHERWISE. COORDINATE EXACT LOCATIONS WITH SERVICE ACCESS NEEDS FOR BOTH NEW AND EXISTING EQUIPMENT WITH THE ARCHITECT'S DRAWINGS AND WITH THE LOCATIONS OF EQUIPMENT OR APPARATUS WHICH THEY SERVE.
- SEE SPECIFICATIONS AND ARCHITECTURAL SHEETS FOR CONSTRUCTION PHASING REQUIREMENTS. DURING EACH PHASE, AS MUCH WORK AS POSSIBLE MUST BE PERFORMED WITHIN THE BOUNDARIES OF THAT PHASE.
- THE EXISTING BUILDING SHALL REMAIN IN CONTINUOUS AND NON-INTERRUPTED OPERATION DURING REMODELING/ALTERING OF THE EXISTING BUILDING. THE SPECIFIC AREA(S) BEING REMODELED/ALTERED AT ANY SCHEDULED TIME ARE OBVIOUSLY EXCLUSIVE OF THIS STATEMENT. SERVICES TO EXISTING BUILDING SHALL BE KEPT ON CONTINUOUS OPERATION INCLUDING SUPPLY, RETURN, EXHAUST, RELIEF, AND OUTSIDE AIR, ETC. ANY ABSOLUTELY NECESSARY INTERRUPTION OF THESE SERVICES TO ACCOMPLISH PROJECT CONSTRUCTION, SHALL BE ARRANGED WITH THE OWNER THROUGH THE GENERAL CONTRACTOR, A MINIMUM OF TWO (2) WEEKS IN ADVANCE. TEMPORARY SERVICES SHALL BE FURNISHED WHERE NECESSARY TO ACCOMPLISH THIS PURPOSE. TEMPORARY SERVICES SHALL BE REMOVED ONLY AFTER NEW PERMANENT SERVICES ARE INSTALLED AND FULLY OPERATIONAL.
- THIS CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN DEMOLITION, REMOVAL, CAPPING, STORING, ABANDONING, DISCONNECTING, RELOCATING AND RECONNECTION OF EXISTING EQUIPMENT AND MATERIAL. ALL CUTTING, PATCHING, REPAIRING, REPLACEMENT AND REFINISHING, SHALL MATCH THE EXISTING CONSTRUCTION AS NEARLY AS POSSIBLE AND SHALL RESULT IN A COMPLETE, INSULATED, AND OPERATIONAL SYSTEM.
- EXCEPT WHERE OTHERWISE SHOWN OR NOTED ON DRAWING - "TO BE RETAINED, RELOCATED" OR HEREINAFTER NOTED, ALL EXISTING EQUIPMENT AND MATERIAL IN AREAS TO BE REMODELED/ALTERED SHALL BE REMOVED WHERE THEY INTERFERE WITH PROPOSED NEW CONSTRUCTION AND/OR INTERFERE WITH PROPOSED USAGE OF SPACE BY OWNER AS FOLLOWS:
 - REMOVE ANY DUCTS PROTRUDING ABOVE FINISHED FLOOR OR THROUGH WALL, CAP AND SEAL, AND FINISH OVER WITH MATERIAL TO MATCH EXISTING.
 - REMOVE ALL AIR DEVICES AND DAMPERS AS NOTED. CAP AT NEAREST ACTIVE MAIN. REMOVE ABANDONED DUCTWORK BACK TO MAINS.
 - IN REMODELED/ALTERED AREAS ANY DUCTWORK PASSING THROUGH THE REMODELED AREAS TO SERVE (OR BEING SERVED FROM) EXISTING ADJACENT, REMOTE, OR SURROUNDING AREA THAT ARE TO REMAIN, SHALL BE RETAINED AND KEPT OPERATIONAL, AND SHALL BE REROUTED IN ALL CASES WHERE THEY INTERFERE WITH ANY NEW WORK OR USAGE TO BE ACCOMPLISHED IN THE REMODELED AREA.
 - PENETRATIONS THROUGH EXISTING WALLS AND FLOORS FORMERLY OCCUPIED BY REMOVED DUCTWORK SHALL BE PATCHED TO MATCH EXISTING CONSTRUCTION.
- THIS CONTRACTOR SHALL REFER TO ARCHITECTURAL DRAWINGS TO FAMILIARIZE THEMSELVES WITH EXTENT OF ALTERATION/REMODELING WORK AND MORE SPECIFICALLY NOTE WHERE NEW PARTITIONING IS BEING INSTALLED, WHERE EXISTING PARTITIONING IS BEING REMOVED, WHERE CEILINGS ARE BEING REMOVED AND OR REPLACED, ETC.

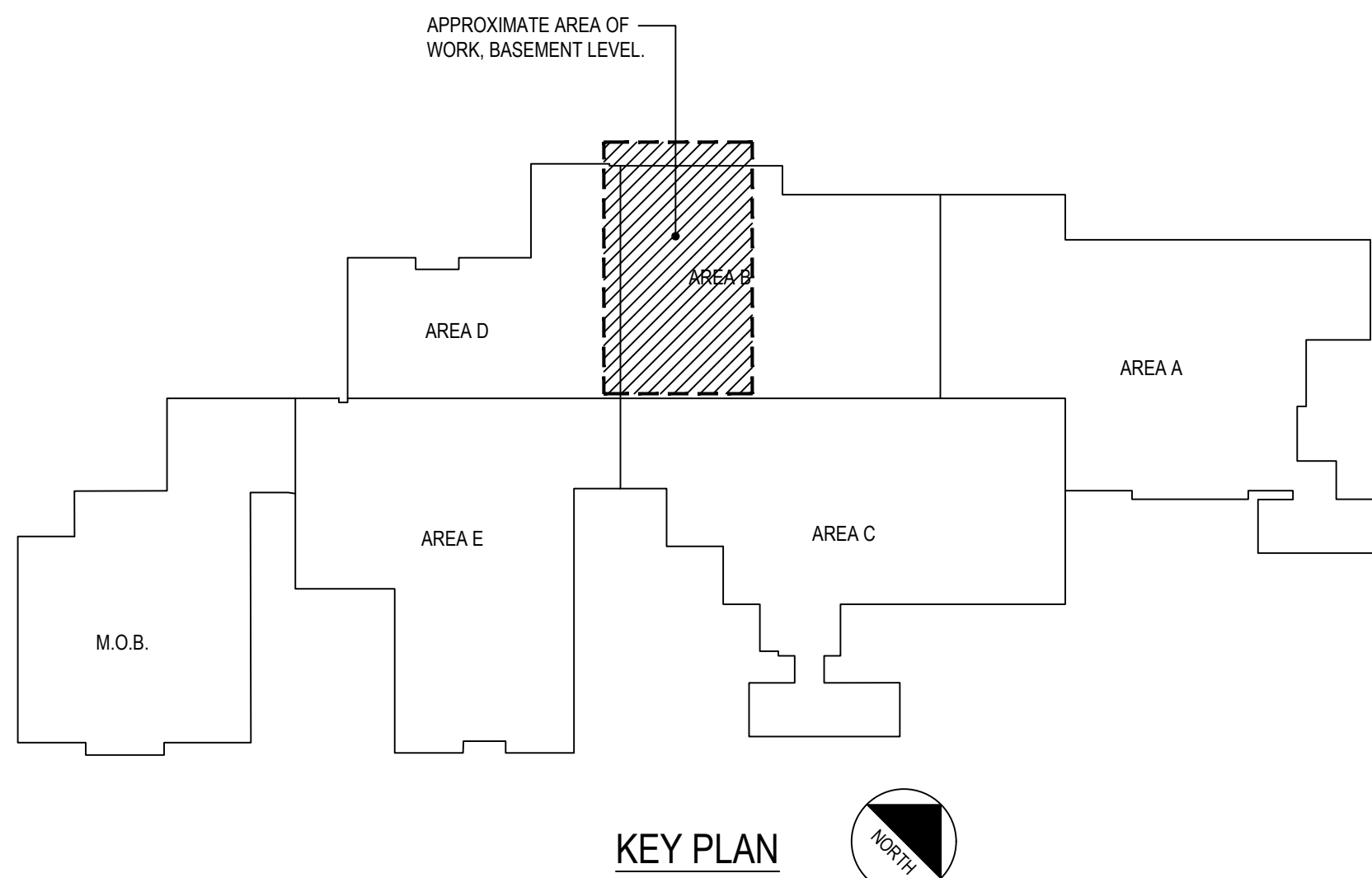
PIPE SYSTEM DESIGNATIONS			
HYDRONIC SYSTEMS			
CR	CONDENSER RETURN		
CS	CONDENSER SUPPLY		
CCR	CONDENSER RETURN - CLOSED		
CCS	CONDENSER SUPPLY - CLOSED		
CHR or CWR	CHILLED WATER RETURN		
CHS or CWS	CHILLED WATER RETURN		
RFR	RADIANT FLOOR RETURN		
RFS	RADIANT FLOOR SUPPLY		
GF	GLYCOL FEED		
GLR	GEOTHERMAL LOOP RETURN		
GLS	GEOTHERMAL LOOP SUPPLY		
HWR	HEATING WATER RETURN		
HWS	HEATING WATER SUPPLY		
SMR	SNOWMELT HEATING RETURN		
SMS	SNOWMELT HEATING SUPPLY		
STEAM SYSTEMS			
HPR	CONDENSATE RETURN - HIGH PRESSURE		
HPS	STEAM SUPPLY - HIGH PRESSURE		
LPR	CONDENSATE RETURN - LOW PRESSURE		
LPS	STEAM SUPPLY - LOW PRESSURE		
MPR	CONDENSATE RETURN - MEDIUM PRESSURE		
MPS	STEAM SUPPLY - MEDIUM PRESSURE		
PC	PUMP CONDENSATE		

PLUMBING SYSTEM DESIGNATIONS			
AIR SYSTEMS			
CA	COMPRESSED AIR		
DOMESTIC SYSTEMS			
CW	DOMESTIC COLD WATER		
HW	DOMESTIC HOT WATER		
HWC	DOMESTIC HOT WATER RECIRCULATION		
HW	DOMESTIC HOT WATER		
140°F HW	140°F DOMESTIC HOT WATER		
140°F HWC	140°F DOMESTIC HOT WATER		
NS	NON SOFTENED WATER		
GAS SYSTEMS			
G	NATURAL GAS		
MG	MEDIUM PRESSURE GAS		
PG	PROPANE GAS		
PD	PROPANE DRAIN		
RAD	RADON VENTING		
SANITARY SEWER / WASTE SYSTEMS			
AW	ACID WASTE		
AV	ACID VENT		
GW	GREASE WASTE		
GV	GREASE VENT		
PW	PUMPED WASTE		
W or SS	SANITARY SEWER / WASTE		
V	SANITARY VENT		
SO	SAND & OIL WASTE		
RD or ST	ROOF DRAIN / STORM DRAIN		
OD or ST(OF)	OVERFLOW DRAIN / STORM OVERFLOW DRAIN		

PLAN SYMBOLS LEGEND	
PLAN	DESCRIPTION
	DRAWING FLAG NOTE
	DEMOLITION DRAWING FLAG NOTE
	REVISION CLOUD TAG
	SYSTEM DISCONNECT SYMBOL
	SYSTEM NEW CONNECTION SYMBOL
	MECHANICAL EQUIPMENT CALLOUT
	MISC. OWNER EQUIPMENT CALLOUT
	MEDICAL EQUIPMENT CALLOUT
	ELEVATION/SECTION CALLOUT

DUCTWORK LEGEND			
ROUND DUCT		RECTANGULAR DUCT	
3D	PLAN	3D	PLAN

PLUMBING FIXTURE CONNECTION SCHEDULE				
ABBREVIATION	DESCRIPTION	CW	HW	WASTE
FD	FLOOR DRAIN	-	-	2" (min)
FS	FLOOR SINK	-	-	3" (min)
L or LAV	LAVATORY	1/2"	1/2"	2" 1-1/2"
MSB	MOP SERVICE BASIN	1/2"	1/2"	2" 1-1/2"
S	SINK	1/2"	1/2"	2" 1-1/2"
SH	SHOWER	1/2"	1/2"	2" 2"
TUB	BATH/TUB	1/2"	1/2"	2" 2"
UR	URNAL (FLUSH VALVE)	1"	-	2" 2"
UR	URNAL (WATERLESS)	-	-	2" 2"
WC	WATER CLOSET (FLUSH TANK)	1"	-	4" 2"
WC	WATER CLOSET (FLUSH VALVE)	1"	-	4" 2"
WH	WALL HYDRANT	1/2" (min)	-	-
REMARKS:				
1. MINIMUM DOMESTIC WATER PIPING SIZE TO ANY TWO OR MORE FIXTURES SHALL BE 3/4".				
MINIMUM DOMESTIC COLD WATER PIPING TO ANY ONE FLUSH VALVE WATER CLOSET PLUS ANY ONE ADDITIONAL FIXTURE SHALL BE 1-1/4".				
MINIMUM DOMESTIC COLD WATER PIPING TO ANY TWO FLUSH VALVE WATER CLOSETS SHALL BE 1-1/4".				
MINIMUM DOMESTIC COLD WATER PIPING TO ANY THREE FLUSH VALVE WATER CLOSETS SHALL BE 1-1/2".				
MINIMUM DOMESTIC COLD WATER PIPING TO ANY FOUR FLUSH VALVE WATER CLOSETS SHALL BE 2".				
2. SIZES INDICATED ARE MINIMUM PIPE SIZES TO A SINGLE FIXTURE AND CONTEMPLATE INDIVIDUAL VENTING OF EACH FIXTURE. VENT CONNECTION MAY BE OMITTED WHERE SHOWN IN ISOMETRICS AND COMMON VENTING OR SIMILAR METHODS ARE EMPLOYED.				
3. MINIMUM SIZES NOTED ABOVE MAY BE SUPERCEDED BY LARGER SIZES SHOWN ON PLANS.				
4. NOT ALL FIXTURE TYPES LISTED ABOVE ARE NECESSARILY USED THIS PROJECT.				
5. MULTIPLE TYPES OF A GIVEN FIXTURE (IE SH-1, SH-2, ETC) MAY OCCUR. REFER TO SPECIFICATIONS FOR DETAILED REQUIREMENTS.				
6. MINIMUM WASTE & VENT PIPING SIZE SHALL BE 1-1/2" THROUGHOUT THE PROJECT.				
7. ADDITIONAL PLUMBING FIXTURE CONNECTION TYPES (IE COFFEE MAKER, ICE MAKER BOXES, ETC) MAY OCCUR ON THE PROJECT THAT ARE NOT LISTED ABOVE.				
8. PROVIDE ICE MAKER BOX ROUGH-IN WITH 1/2" WATER CONNECTION AND HAMMER ARRESTOR FOR ALL REFRIGERATORS IN NON-HARDENED CONSTRUCTION AREAS.				



PIPING LEGEND	
PLAN	DESCRIPTION
	PIPE UP
	PIPE DN
	PIPE TEE
	PIPE ANCHOR
	PIPE CAP
	PIPE EXPANSION JOINT
	PIPE FLEXIBLE CONNECTION
	PUMP / EQUIPMENT CONNECTOR
VALVES / ACCESSORIES	
	AIR VENT
	BUTTERFLY VALVE
	CHECK VALVE
	DOUBLE CHECK BACKFLOW PREVENTER
	DRAIN VALVE WITH HOSE END
	FLOW SWITCH
	GATE VALVE
	GLOBE VALVE
	ISOLATION BALL VALVE
	PLUG VALVE
	FLOW BALANCING VALVE
	PRESSURE GAUGE
	PRESSURE REDUCING STATION
	PRESSURE TEMPERATURE TAP
	SAFETY RELIEF VALVE
	SENSOR (MISCELLANEOUS, REFER TO PLANS)
	SOLENOID VALVE
	SHOCK ABSORBER
	STRAINER
	STRAINER WITH BLOW-OFF VALVE
	STRAINER WITH VALVE
	2-WAY TEMPERATURE CONTROL VALVE
	3-WAY TEMPERATURE CONTROL VALVE
	TEMPERATURE CONTROLLER OR SENSOR
	THERMOMETER
	UNION
	VACUUM BREAKER
	VENTURI / FLOW INDICATOR
FIXTURES / DRAINS / CLEANOUTS / TRAPS	
	FLOOR DRAIN
	FLOOR SINK
	FLOOR CLEANOUT
	HORIZONTAL CLEANOUT
	HOSE BIBB OR WALL HYDRANT
	ROOF DRAIN
	STEAM TRAP
	STEAM TRAP TEST CHAMBER

ABBREVIATIONS	
AAV	AIR ADMITTANCE VALVE
ADA	AMERICANS WITH DISABILITIES ACT
AF/AT	AMP FRAME, AMP TRIP
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AIC	AMPERES INTERRUPTING CAPACITY (SYMMETRICAL)
AMP or A	AMPERES
ASAF	AMP SWITCH, AMP FUSE
ATS	AUTOMATIC TRANSFER SWITCH
AVG	AVERAGE
AWG	AMERICAN WIRE GAUGE
BAS	BUILDING NONMETALLIC SYSTEM
BGF	BELOW FINISHED GRADE
C	CONDUIT
CB	CIRCUIT BREAKER
CIRC. CKT	CIRCUIT
CT	CURRENT TRANSFORMER
DEM. SHUT	DEMOLITION
(D) or GMD	DISCONNECT
(E)	EXISTING
EF	EXHAUST FAN
EMT	ELECTRICAL METALLIC TUBING
ENT	ELECTRICAL NONMETALLIC TUBING
EPD	EMERGENCY POWER OFF
(F)	FUTURE
FA	FIRE ALARM
FCT	FOR CONTINUATION
FFI	FOR FURTHER INFORMATION
FLA	FULL LOAD AMPS
FSD	FIRE SMOKE DAMPER
FT or ' "	FEET
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GRD	GROUND
W.D.H.L	WIDTH, DEPTH, HEIGHT, LENGTH
HCA	HAND-OFF CUT
HP	HORSEPOWER
HVAC	HEATING, VENTILATION, AND AIR CONDITIONING
IG	ISOLATED GROUND
IN or ' "	INCHES
JBOX	JUNCTION BOX
KVA	KILOVOLT AMPERES
KW	KILOWATT
KWH	KILOWATT HOUR
LF	LINEAR FEET
LTG or LFS	LIGHTING
METER	METER
MAX	MAXIMUM
MCA	MINIMUM CIRCUIT AMPACITY
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCN	THOUSAND CIRCULAR MILS
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MLO	MAIN LUGS ONLY
MO	MAXIMUM OVERCURRENT PROTECTION
MON	MONITORING
MTD	MOUNTED
(N)	NEW
NO / NO	NORMALLY CLOSED / NORMALLY OPEN
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NF	NON-FUSED
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
No. or #	NUMBER
NTS	NOT TO SCALE
GFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
P	POLE
PC	PHOTOCELL
PH	PHASE
PROVIDE	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE
(R)	RELOCATED
RE	REFER TO
REC or RECP	RECEPTACLE
RGS	RIGID GALVANIZED STEEL
RMS	ROOT MEAN SQUARE
SF	SQUARE FEET
SPD	SURGE PROTECTION DEVICE
SPST	SINGLE-POLE, SINGLE-THROW
SQ	SQUARE
TC	TIMECLOCK
TEL/DATA	TELEPHONE/DATA
TV	TELEVISION
TYP	TYPICAL
UGPS	UNDERGROUND PULL SECTION
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SYSTEM
V	VOLTS
VA	VOLT AMPERES
VAV	VARIABLE AIR VOLUME
VD	VOLTAGE DROP
VFD	VARIABLE FREQUENCY DRIVE
W	WIRE
W/	WITH
WP	WEATHERPROOF
XFRM	TRANSFORMER
%Z	PERCENTAGE IMPEDANCE

SHEET INDEX - MECHANICAL / PLUMBING

NUMBER	NAME	DELIVERABLE
MP000	MECHANICAL NOTES, LEGENDS, & SCHEDULES	•
P100	PARTIAL LOWER LEVEL LAUNDRY PLUMBING DEMOLITION PLAN	•
P200	PARTIAL LOWER LEVEL LAUNDRY MECHANICAL NEW WORK PLAN	•
M100	PARTIAL LOWER LEVEL LAUNDRY MECHANICAL DEMOLITION PLAN	•
M200	PARTIAL LOWER LEVEL LAUNDRY MECHANICAL NEW WORK PLAN	•
M300	PARTIAL LOWER LEVEL LAUNDRY PIPING NEW WORK PLAN	•
M400	CHILLED WATER PIPING SCHEMATIC - NEW WORK	•
MP500	MECHANICAL / PLUMBING DETAILS	•
MP500	MECHANICAL / PLUMBING DETAILS	•
M600	MECHANICAL CONTROLS	•

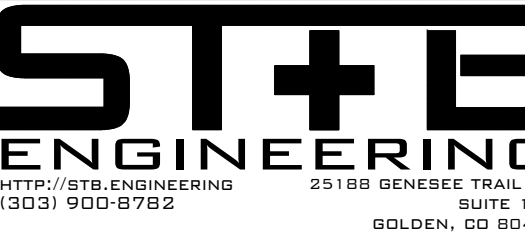
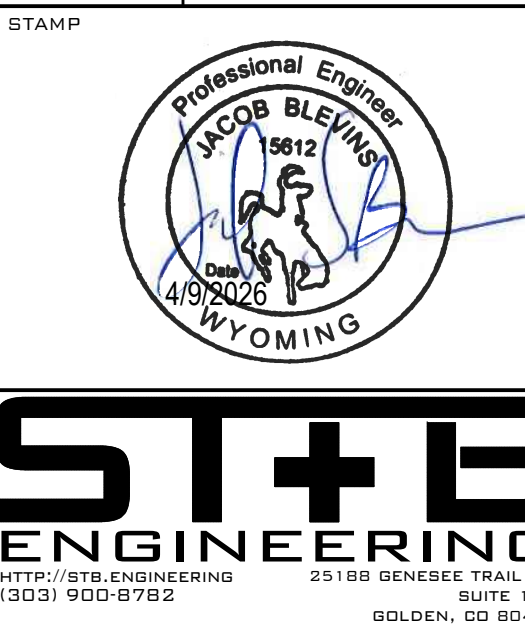
ST-B PROJECT NO.: 2645.24

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	04/11/2026

ST-B PROJECT NO.: 2645.24

MECHANICAL / PLUMBING LEGEND & NOTES

MP000



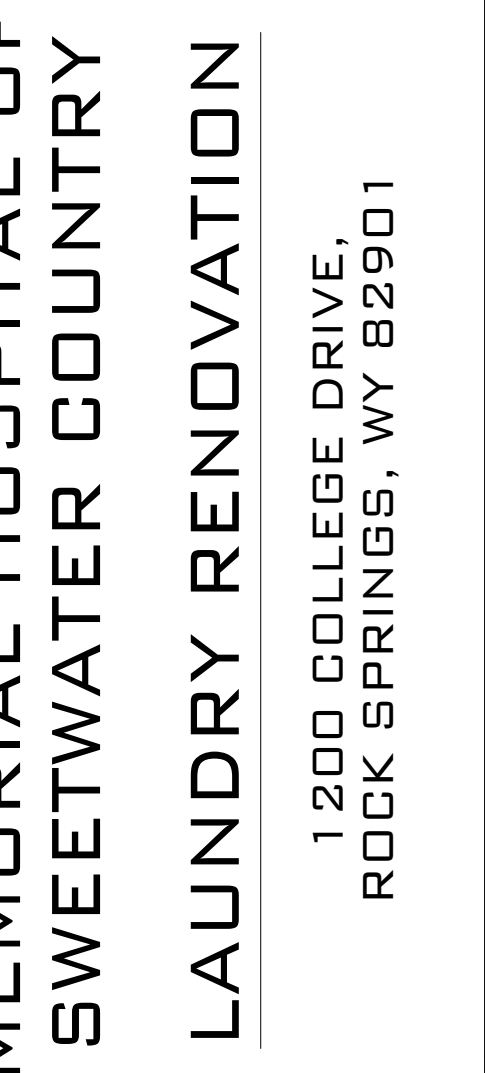
MEMORIAL HOSPITAL OF SWEETWATER COUNTRY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901







- 1 DUCT PIPING PENETRATION THROUGH 8 FT WIDE OA DUCT. PROVIDE PIPING INSULATION AND HEAT TRACE, 10 WLF WITH 120B CONNECTION.
- 2 (N) 2" W UP TO NEW FLOOR SINKS OR FLOOR DRAINS ABOVE. BASED ON ZURN Z415 AND Z119. TYP.
- 3 3/4" CW TO DRYER FIRE SUPPRESSION WITH 3/4-11 1/2 NH THREAD TO MANUFACTURER SUPPLIED HOSE W/ SINGLE FEMALE Y-CONNECTOR.

P200

SHEET NO. _____

P200



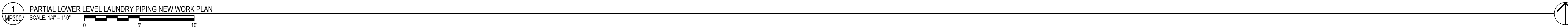
DEMOLITION KEY NOTES TO BE DEVELOPED



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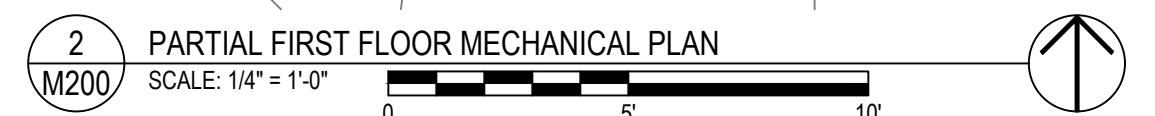
302443 2:28pm STB Projects\302443-24 - M300 - Laundry Renovation\2025\Drawings\M300_New.dwg

1
MP300
PARTIAL LOWER LEVEL LAUNDRY PIPING NEW WORK PLAN
SCALE: 1/4" = 1'-0"



PHASING NOTES:
1. THIS PROJECT REQUIRES PHASING. REFER CONSTRUCTION PHASING NOTES PORTION OF FUNCTIONAL NARRATIVE (SHEET G-000) FOR PRESCRIBED ORDER OF OPERATIONS AND COOPERATE WITH THE GENERAL CONTRACTOR TO MAINTAIN CONTINUITY OF LAUNDRY SERVICES DURING THE RENOVATION PROJECT.
2. NEW PIPING AND REPLACEMENT PIPING SHOWN THIS SHEET EXTENDS OUTSIDE THE BOUNDARIES OF THE ARCHITECTURAL RENOVATION SCOPE AND CONSEQUENTIAL ARCHITECTURAL IMPACTS OF THOSE PATHWAYS ARE NOT SHOWN. PIPING CONTRACTOR SHALL BE RESPONSIBLE TO INCLUDE IN BID AND COORDINATE REQUIRED SCOPE TO FACILITATE THIS INSTALLATION OF NEW AND REPLACEMENT PIPING INCLUDING, BUT NOT LIMITED TO, INTERM LIFE SAFETY MEASURES (LSM) SHOULD EGRESS PATHWAYS BE TEMPORARILY IMPACTED. INFECTOR CONTROL MEASURES, CEILING DECONSTRUCTION, AND CEILING REINSTALLATION.

2
M200
PARTIAL FIRST FLOOR MECHANICAL PLAN
SCALE: 1/4" = 1'-0"

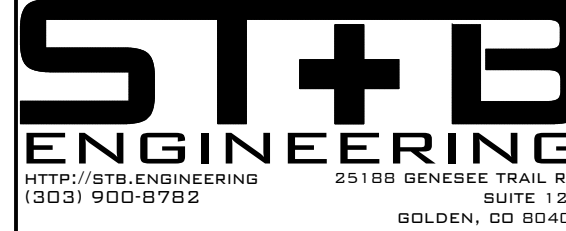


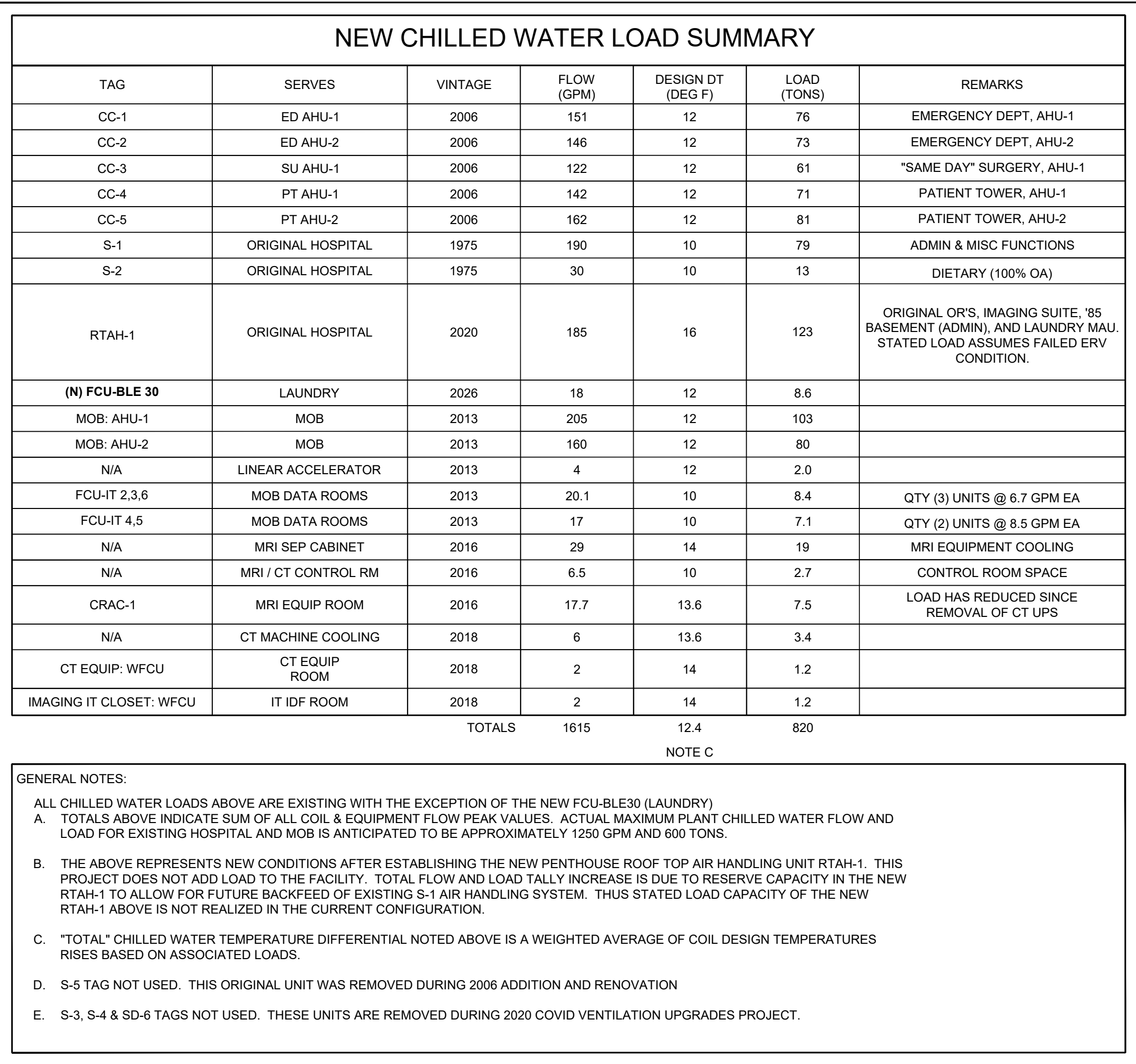
NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	01/1/2025

SHEET NAME
PARTIAL LOWER LEVEL LAUNDRY PIPING NEW WORK PLAN

SHEET NO.
M300

MEMORIAL HOSPITAL OF SWEETWATER COUNTRY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901





Professional Engineer
JACOB BLEWETT
19612
State of Wyoming
4/15/2018
4/15/2023

MEMORIAL HOSPITAL OF
SWEETWATER COUNTRY
LAUNDRY RENOVATION

1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

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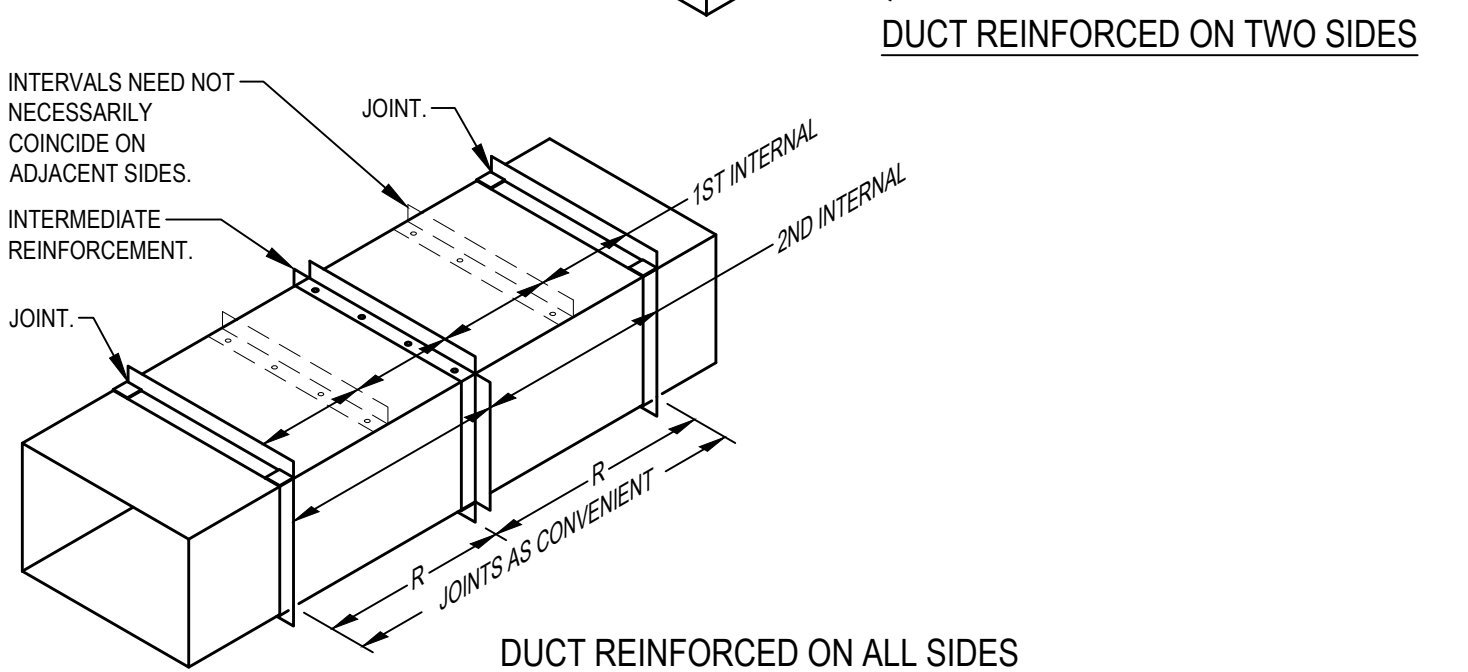
SHEET NAME

CHILLED WATER
SYSTEM SCHEMATIC
- NEW WORK

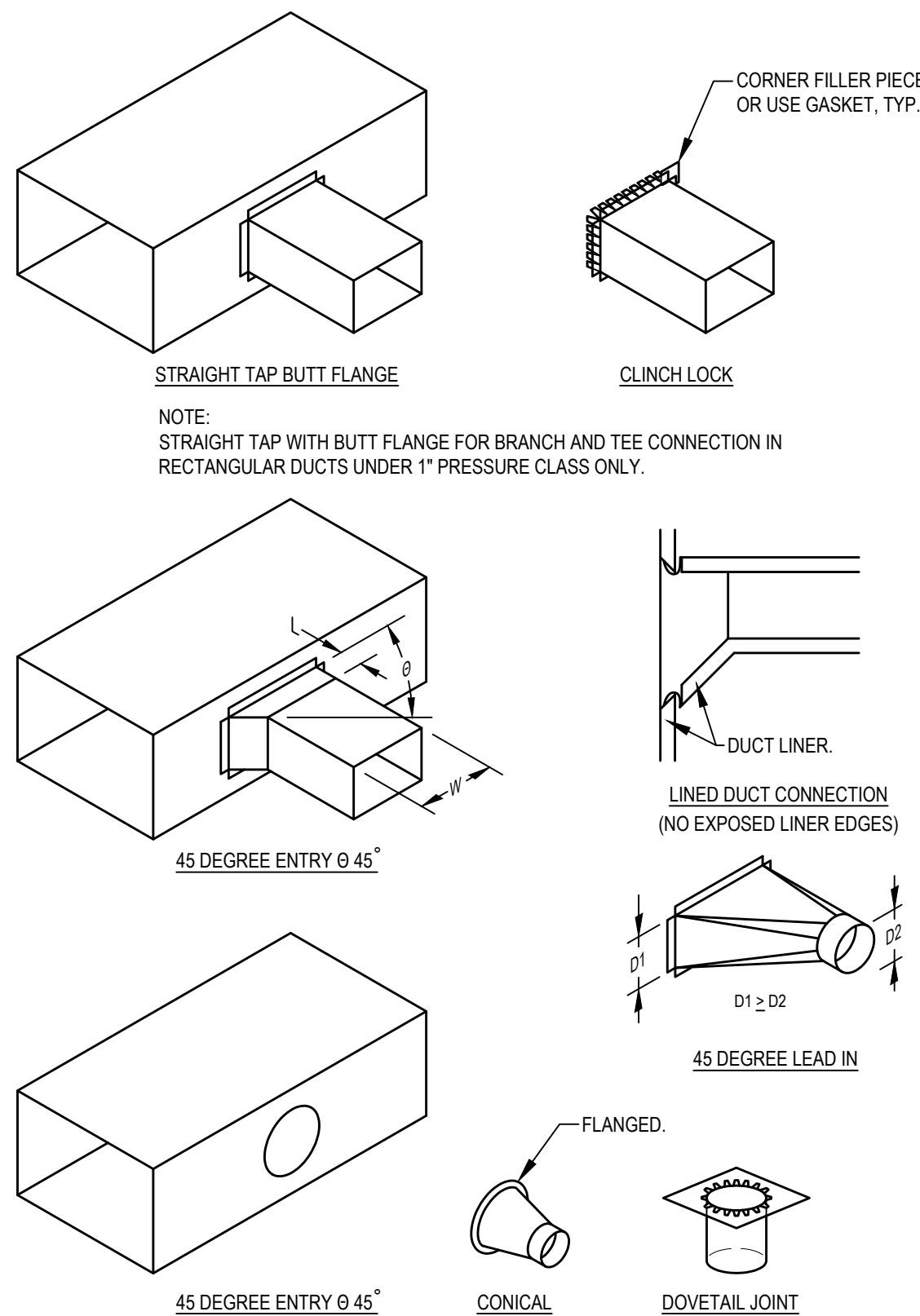
SHEET NO.

M400

- NOTES:
1. 'R' IS AN ALLOWABLE REINFORCEMENT INTERVAL.
 2. TOP AND BOTTOM JOINTS MUST QUALIFY AS REINFORCEMENT.
 3. DUCT SIZES 19" WIDE AND LARGER WHICH HAVE MORE THAN 10 SQ. FT. OF UNBRACED PANEL, SHALL BE BEADED OR CROSS-BROKEN UNLESS DUCT WILL HAVE INSULATION COVERING OR ACOUSTICAL LINER. THIS REQUIREMENT IS APPLICABLE TO 20 GAUGE OR LESS THICKNESS AND 3" WG OR LESS.
 4. RE: SPECIFICATIONS FOR ADDITIONAL INFORMATION.

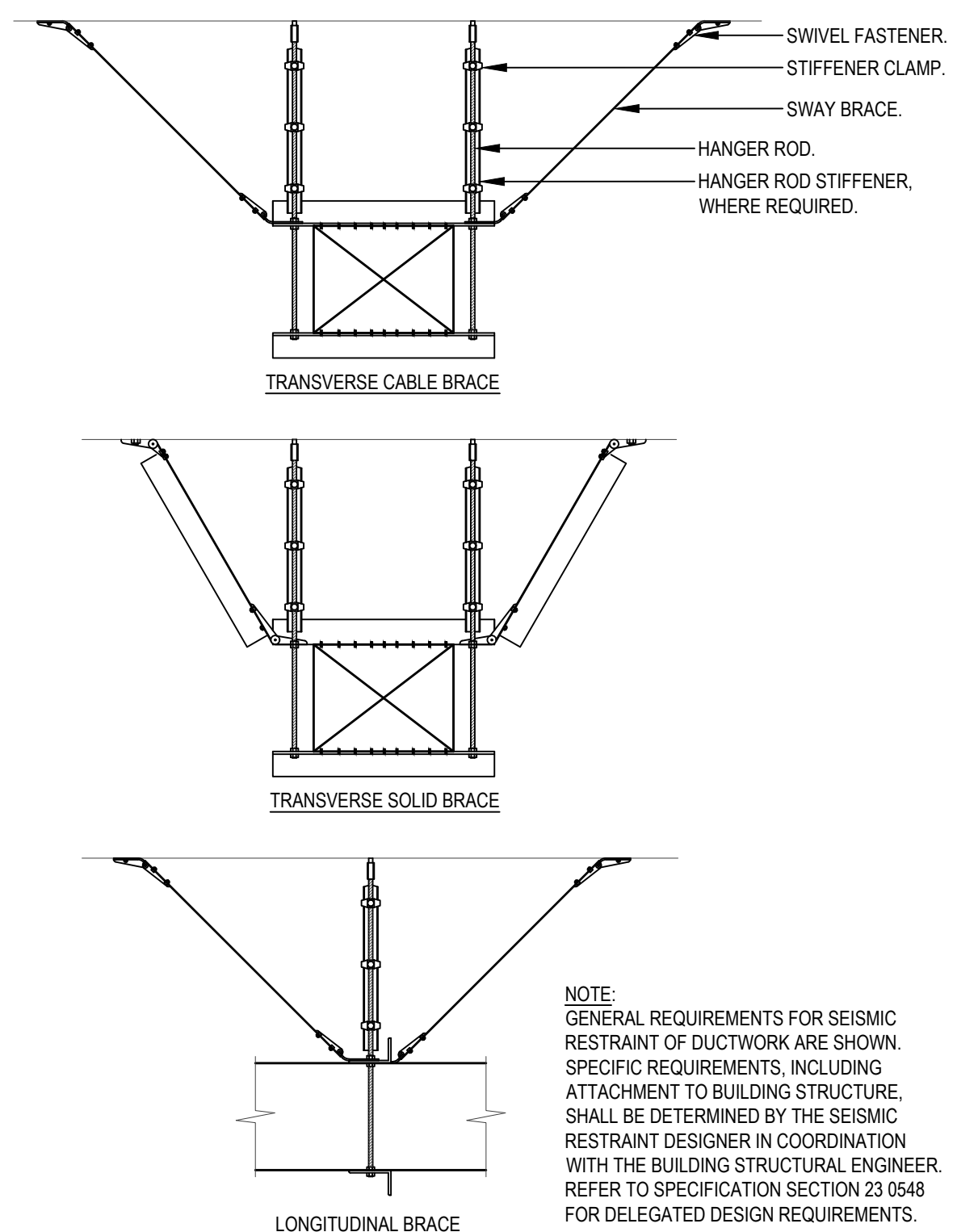


9 DUCT REINFORCEMENT DETAIL
SCALE: NONE 23 3100-06

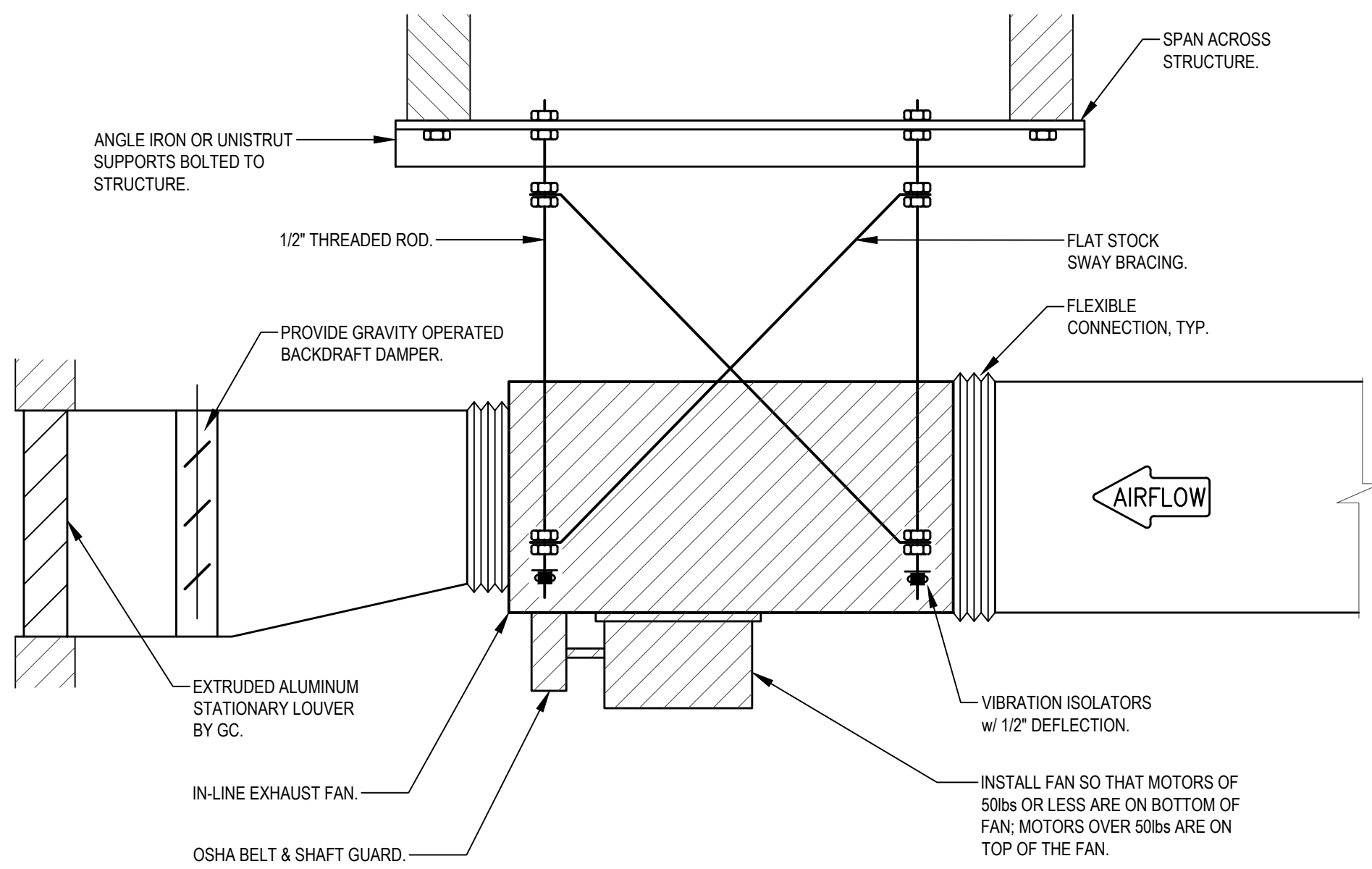


- NOTES:
1. DO NOT USE CONNECTIONS WITH SCOOPS.
 2. FIT ALL CONNECTIONS TO AVOID VISIBLE OPENINGS AND SECURE THEM SUITABLY FOR THE PRESSURE CLASS.
 3. ADDITIONAL MECHANICAL FASTENERS ARE REQUIRED FOR 4" W.G. AND OVER.
 4. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.

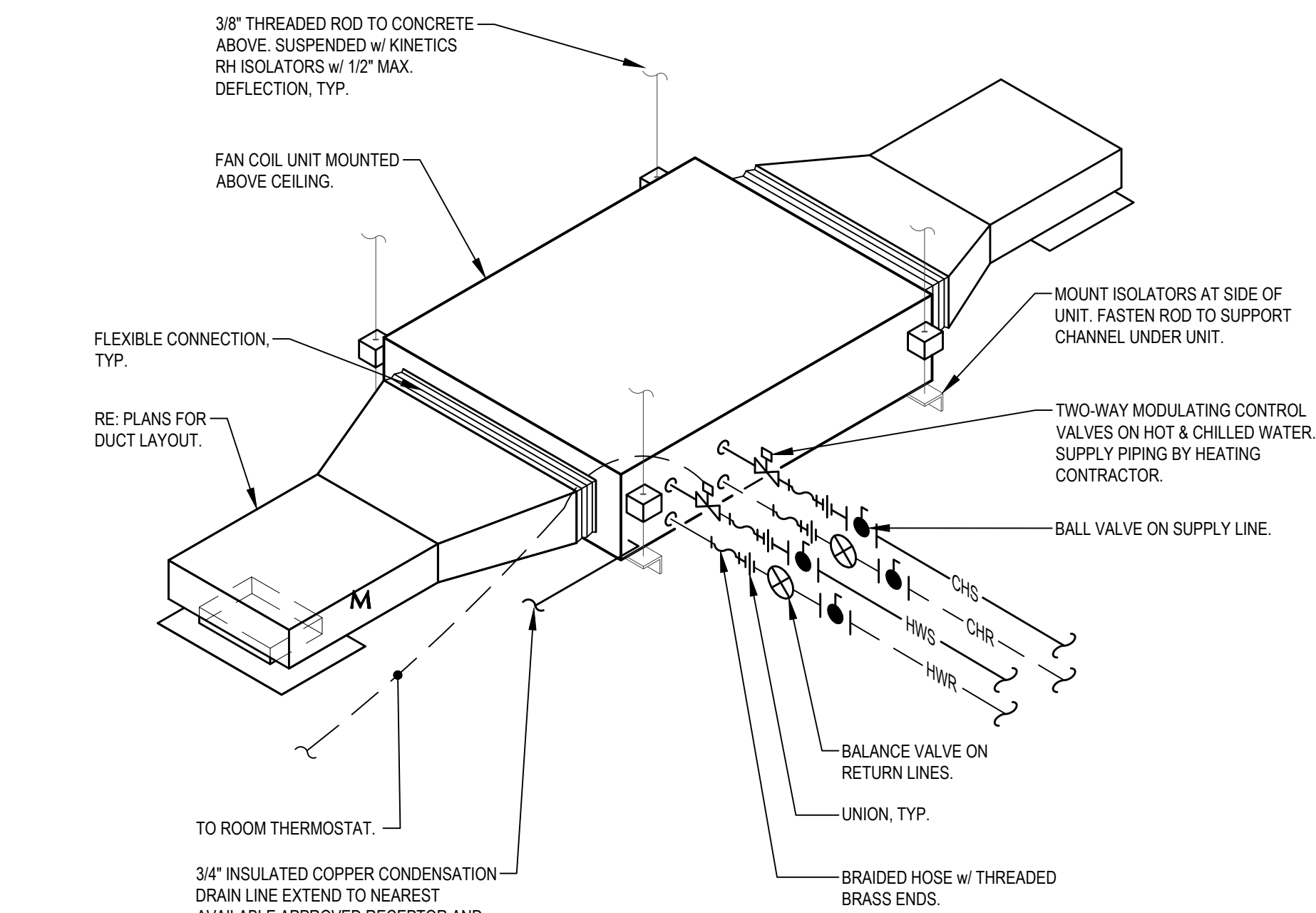
8 BRANCH CONNECTION DETAIL
SCALE: NONE 23 3100-01



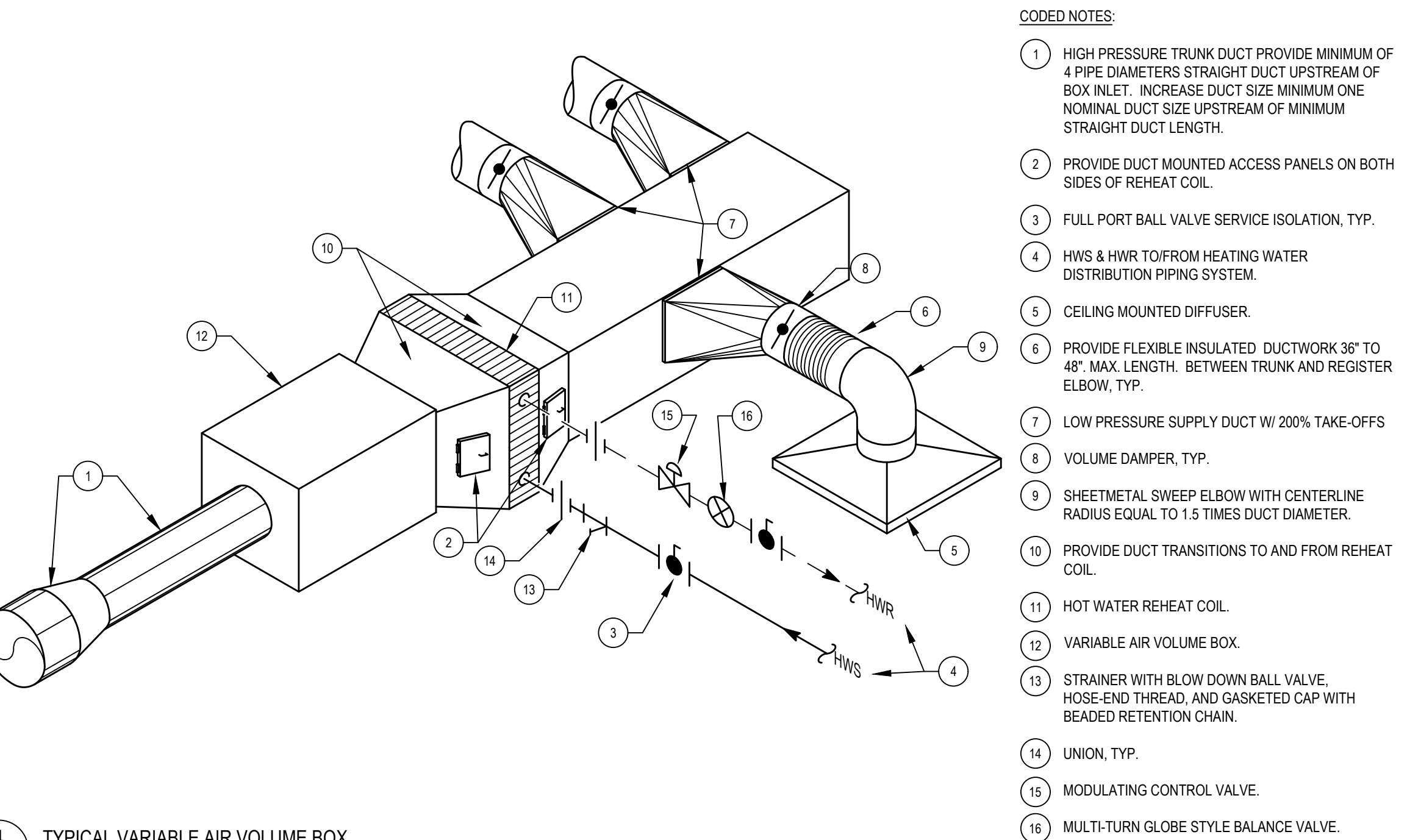
7 SEISMIC BRACING OF SUSPENDED DUCTWORK DETAIL
SCALE: NONE 23 0548-03



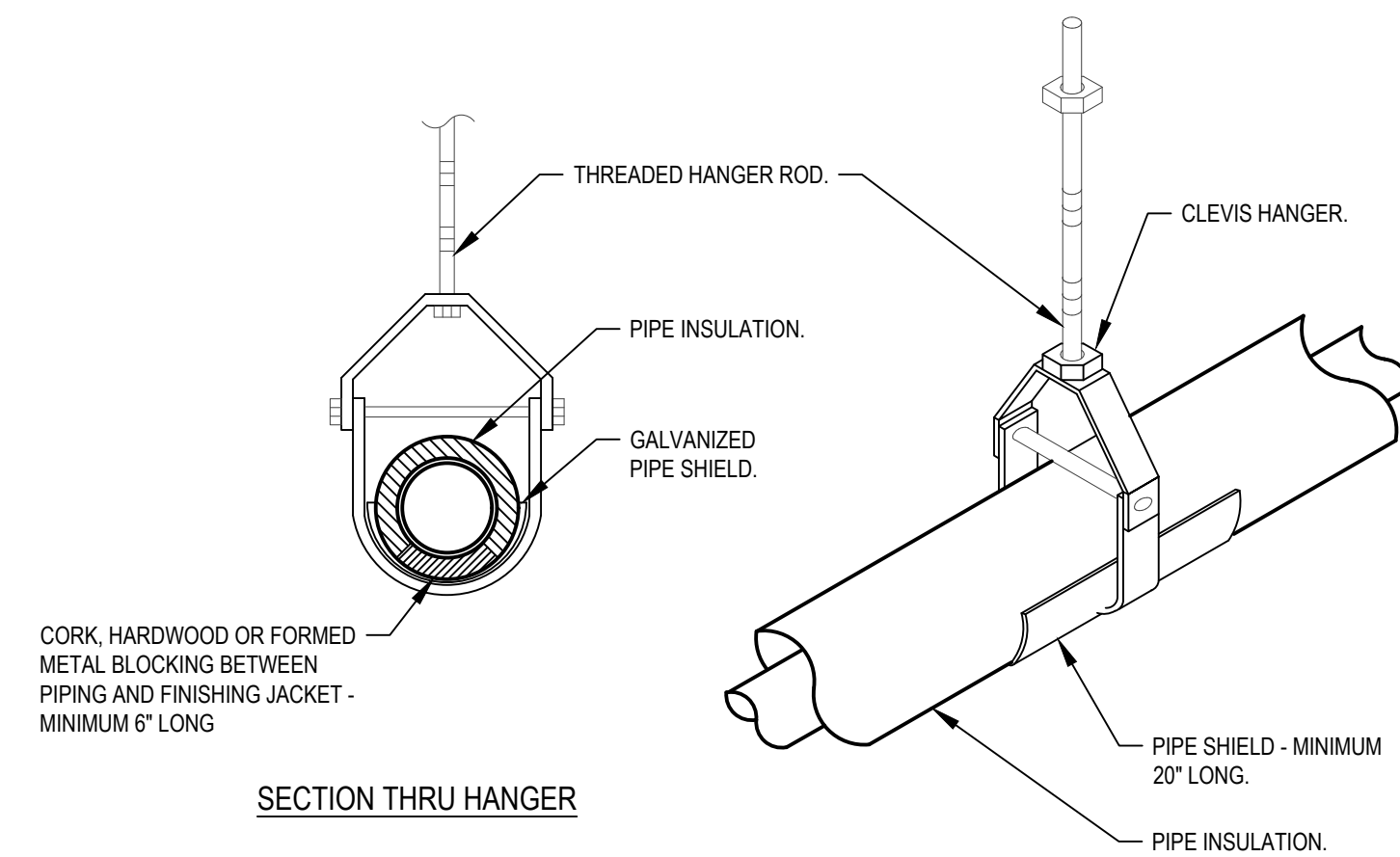
6 INLINE EXHAUST FAN DETAIL - SUSPENDED
SCALE: NONE 23 3423-06



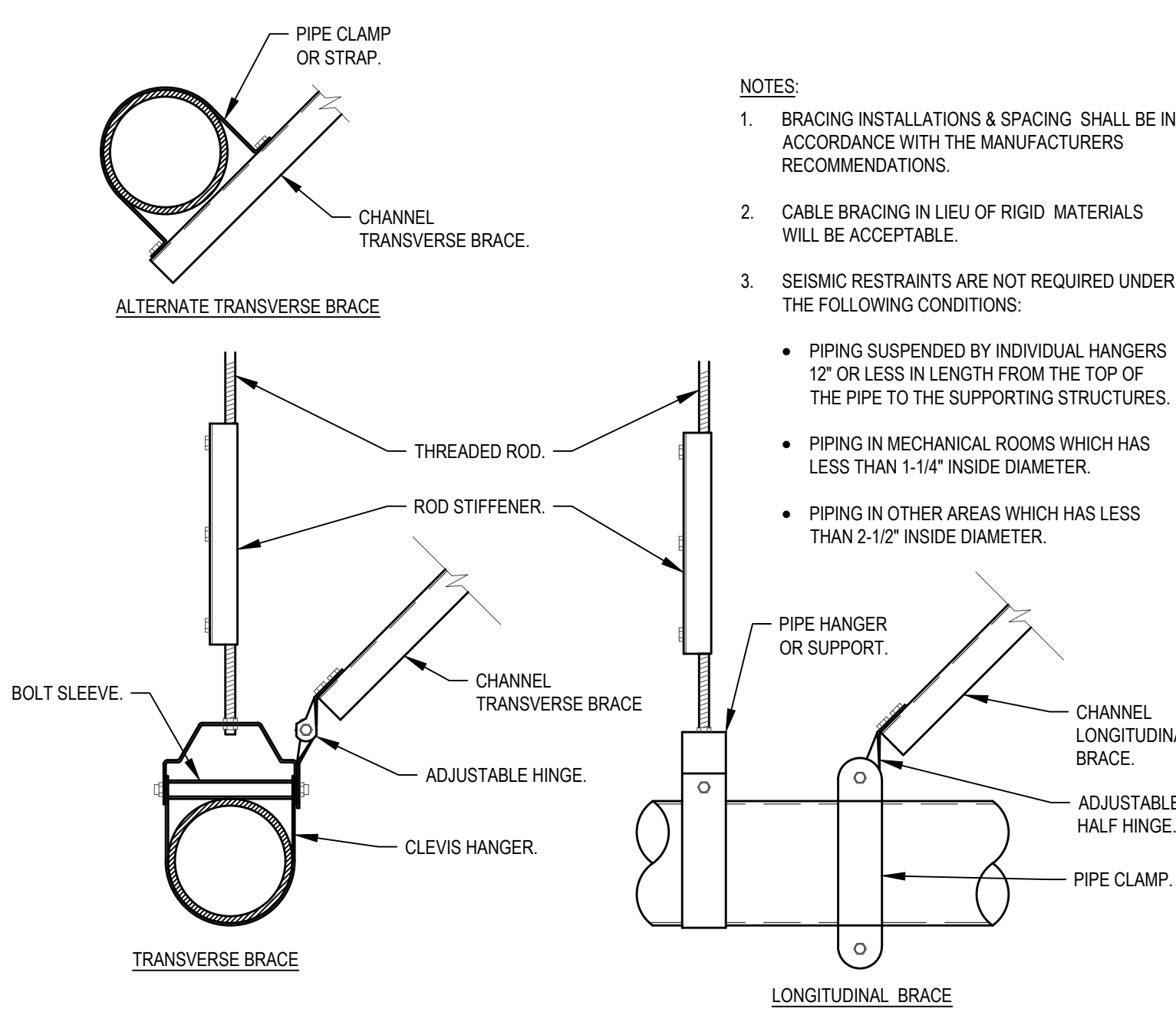
5 FAN COIL UNIT DETAIL - HORIZONTAL, DUCTED, FOUR PIPE
SCALE: NONE 23 8101-02



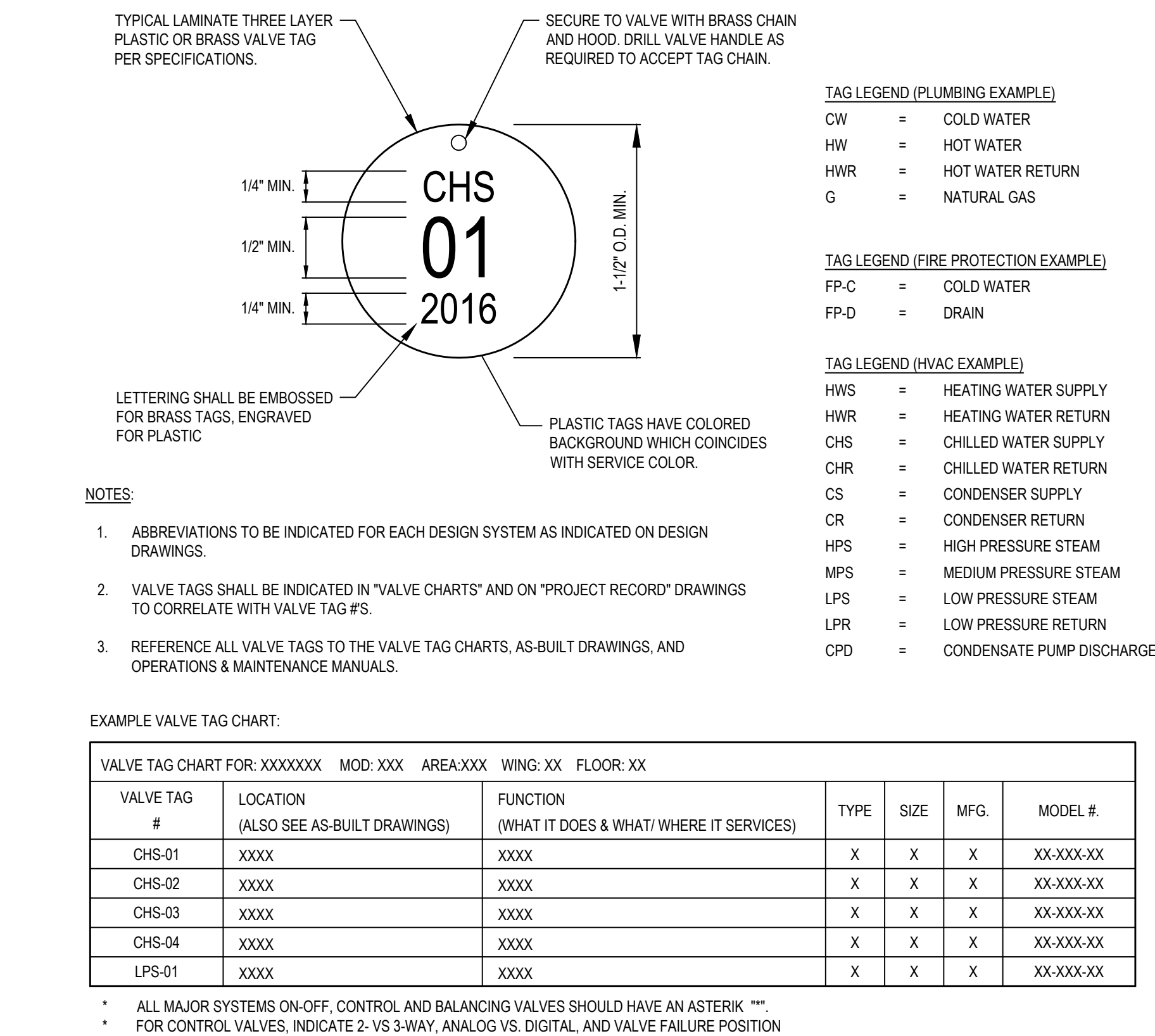
4 TYPICAL VARIABLE AIR VOLUME BOX
SCALE: NONE 23 3600-09



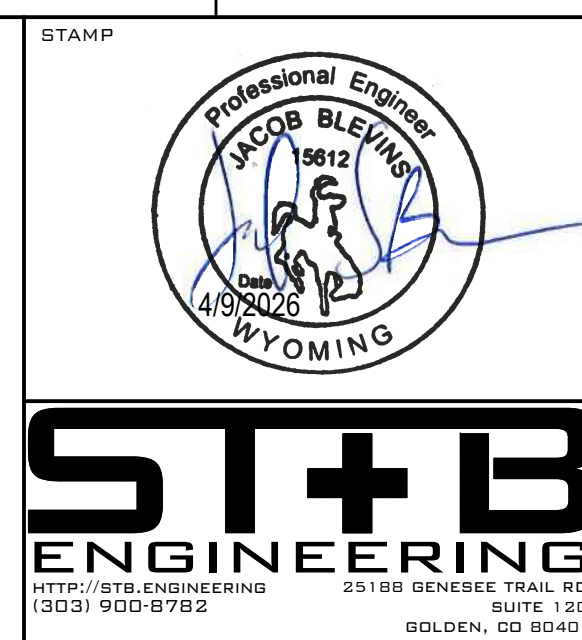
3 TYPICAL PIPE HANGER DETAIL
SCALE: NONE 23 0529-01



2 SINGLE PIPE BRACING FOR SEISMIC REQUIREMENTS DETAIL
SCALE: NONE 23 0529-03



1 MECHANICAL IDENTIFICATION - VALVE TAG AND CHART DETAIL
SCALE: NONE 23 0553-01



MEMORIAL HOSPITAL OF
SWEETWATER COUNTY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

ST-B PROJECT NO.: 2645.24

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	6/11/2026

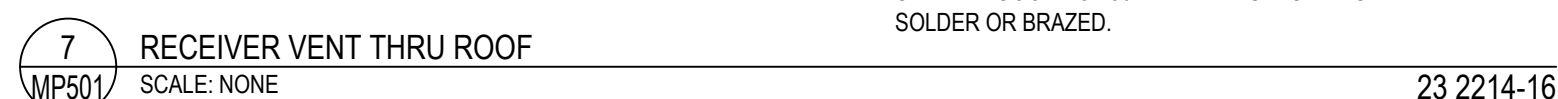
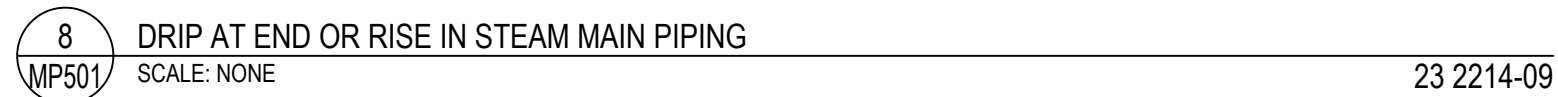
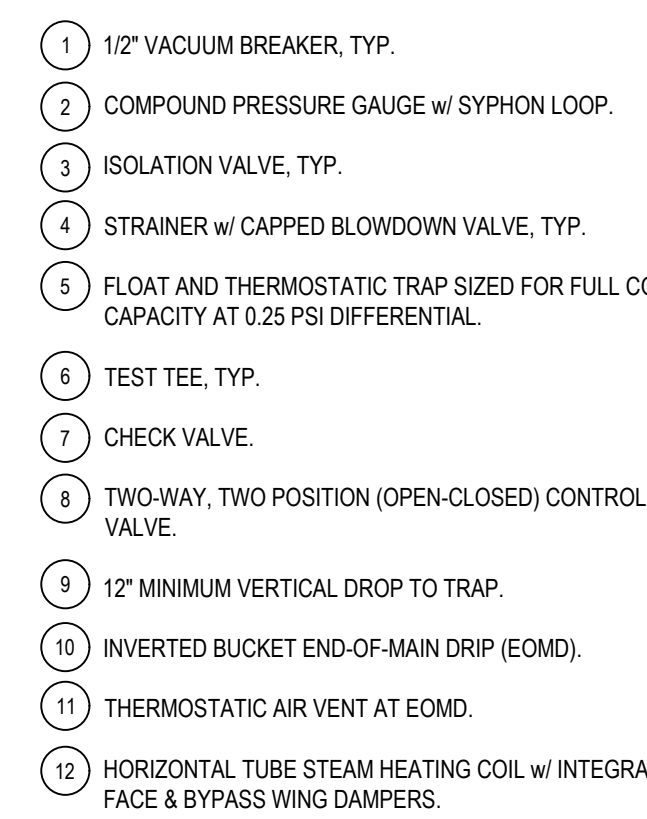
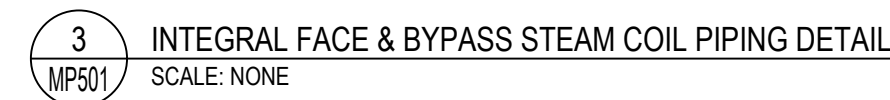
TAG LEGEND (PLUMBING EXAMPLE)
CW = COLD WATER
HW = HOT WATER
HWR = HOT WATER RETURN
G = NATURAL GAS

TAG LEGEND (FIRE PROTECTION EXAMPLE)
FP-C = COLD WATER
FP-D = DRAIN

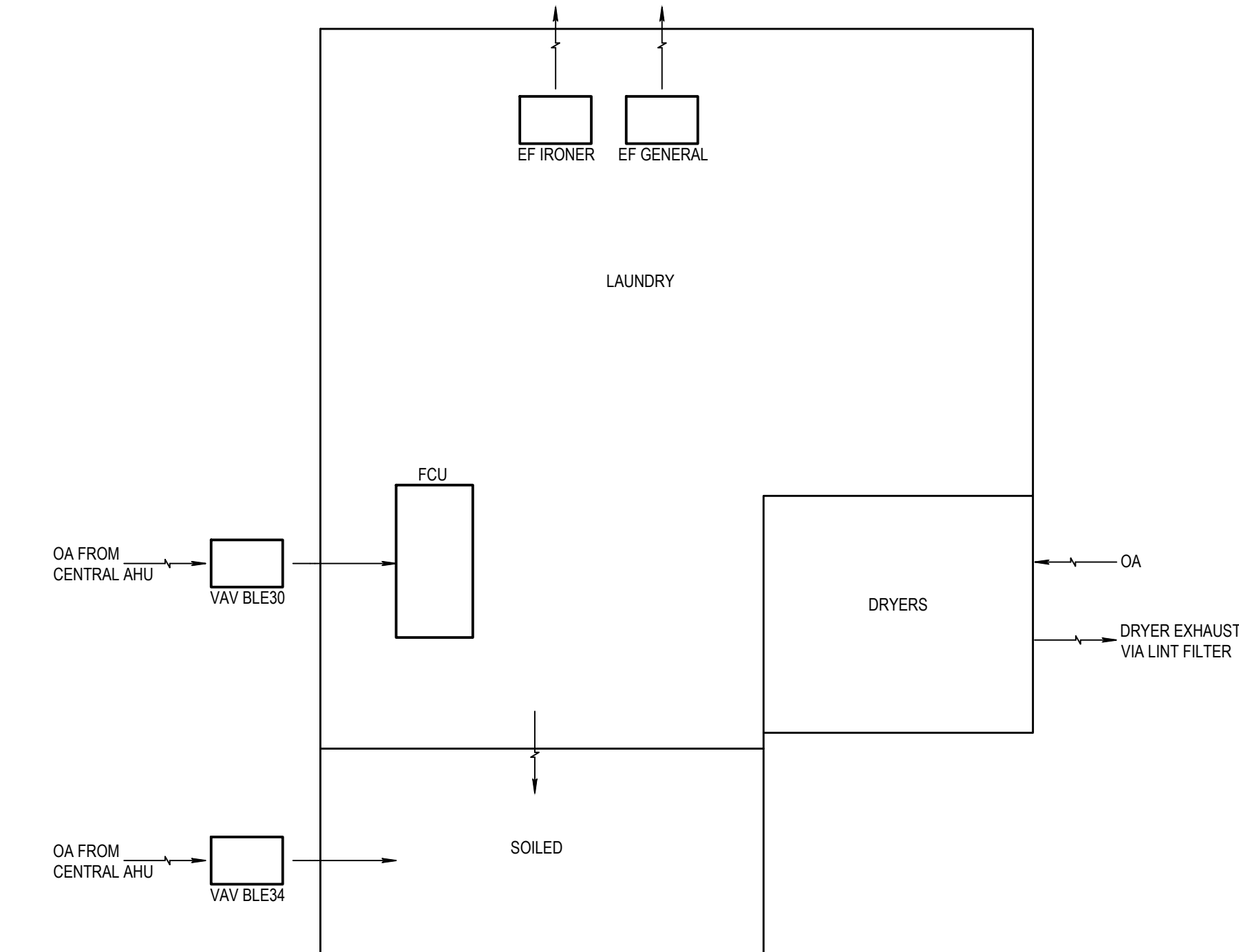
TAG LEGEND (HVAC EXAMPLE)
HWS = HEATING WATER SUPPLY
HWR = HEATING WATER RETURN
CHS = CHILLED WATER SUPPLY
CHR = CHILLED WATER RETURN
CS = CONDENSER SUPPLY
CR = CONDENSER RETURN
HPS = HIGH PRESSURE STEAM
MPS = MEDIUM PRESSURE STEAM
LPS = LOW PRESSURE STEAM
LPR = LOW PRESSURE RETURN
CPD = CONDENSATE PUMP DISCHARGE

MECHANICAL /
PLUMBING DETAILS

MP500



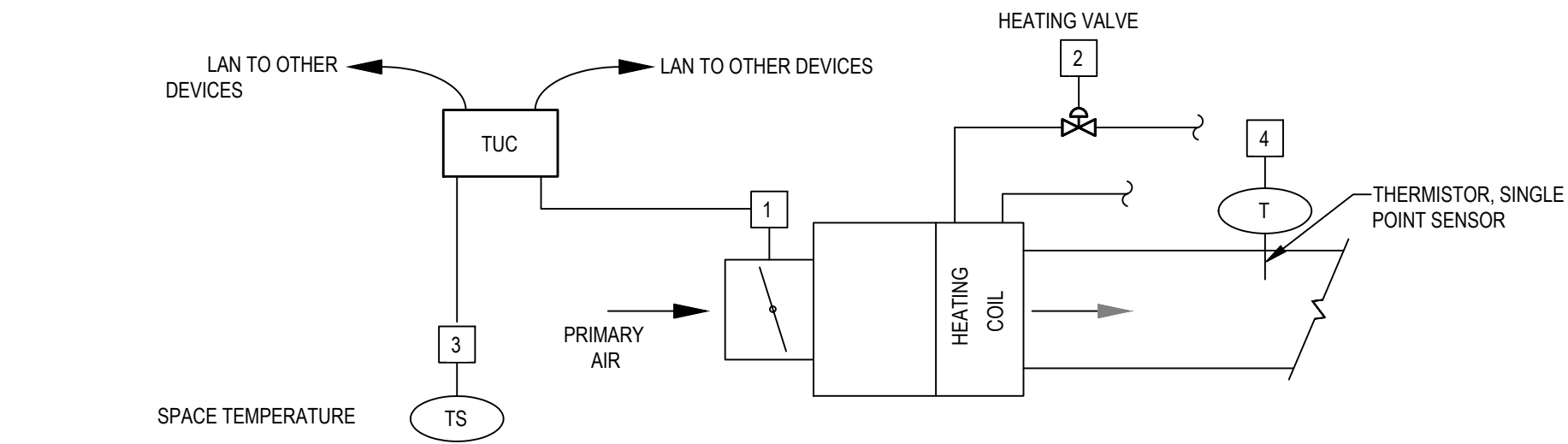
AIR BALANCE SCHEDULE - MHSC LAUNDRY RENOVATION														
ROOM NAME	EQUIPMENT TAG	AREA (SF)	CEILING HEIGHT	VOLUME (CF)	REQUIRED VOLUME		SPACE PRESSURE	DESIGN VOLUME (CFM)				ODA/ACH	ODA(CFM)	REMARKS
					ACH	CFM		SUPPLY	RETURN	EXHAUST	DIFF.			
LAUNDRY BLE30	LAUNDRY, GENERAL EXHAUST FAN LAUNDRY, IRONER EXHAUST VAV SUPPLY FAN COIL UNIT	1400	8	11200	10	1867	NEGATIVE	2000	-	-2200	-200	2	373	2
								-	-	-2000	-			
								0	-	-1450	-			
								1800	-	-	-			
								4000	-1800	-	-			
SOILED LINEN BLE31-33	VAV-BLE34, GENERAL EXH EF-BLE30	420	8	3360	10	560	NEGATIVE	575	NA	-650	-75	0	0	-
STORAGE BLE34	VAV-BLE34, GENERAL EXH EF-BLE30	89	8	712	10	119	NEGATIVE	150	NA	-175	-25	2	24	-
CLEAN LINEN STORAGE, BLE35	VAV-BLE41	508	8	4064	2	135	POSITIVE	0	-350	-	-215	0	0	1
TOTALS		2417				2681							397	



5 AIR BALANCE SCHEMATIC
SCALE: NONE

BAS POINTS LIST							
TAG	NAME/FUNCTION	AI	AO	DI	DO	REMARKS	QTY
1	VAV PRIMARY AIR VALVE		●				1
2	HEATING CONTROL VALVE		●			MODULATING VALVE	1
3	SPACE TEMPERATURE SENSOR	●				ALARM AT BAS	1
4	DISCHARGE AIR TEMPERATURE SENSOR	●					1
5	OCCUPIED COOLING SPACE TEMP. SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
6	OCCUPIED HEATING SPACE TEMP. SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
7	VAV TERMINAL AIRFLOW	●					1
8	MIN VAV AIRFLOW SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
9	MAX VAV AIRFLOW SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
10	HEATING MIN AIRFLOW SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
11	HEAT STATUS (VIA DISCHARGE AIR SENSOR)	●					1
12	UNOCCUPIED COOLING SPACE TEMP. SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
13	UNOCCUPIED HEATING SPACE TEMP. SETPOINT					PROGRAMMABLE SOFTWARE POINT	N/A
14	VALVE OVERRIDE				●		1
15	HEAT OVERRIDE				●		1

- NOTES:
1. HIGH AND LOW TEMP ALARMS AT BAS FOR CRITICAL SPACES (TELECOM, ELECTRICAL, COMPUTER ROOM)
2. PROVIDE TREND DATA FOR ALL POINTS SHOWN. TRENDING DATA SHALL BE STORED USING NON-VOLATILE MEMORY WITHIN THE BAS. DATA SHALL BE RECORDED AT A MINIMUM OF EVERY 15 MINUTES AND KEPT FOR A PERIOD OF A MINIMUM OF 12 MONTHS. THE CONTROL SYSTEM SHALL ALSO BE CAPABLE OF PROVIDING CUSTOM EXPORTS BASED ON SELECTED POINTS AND TIME FRAMES AND EXPORTS SHALL BE PROVIDED IN CSV OR XLS FILE FORMAT.

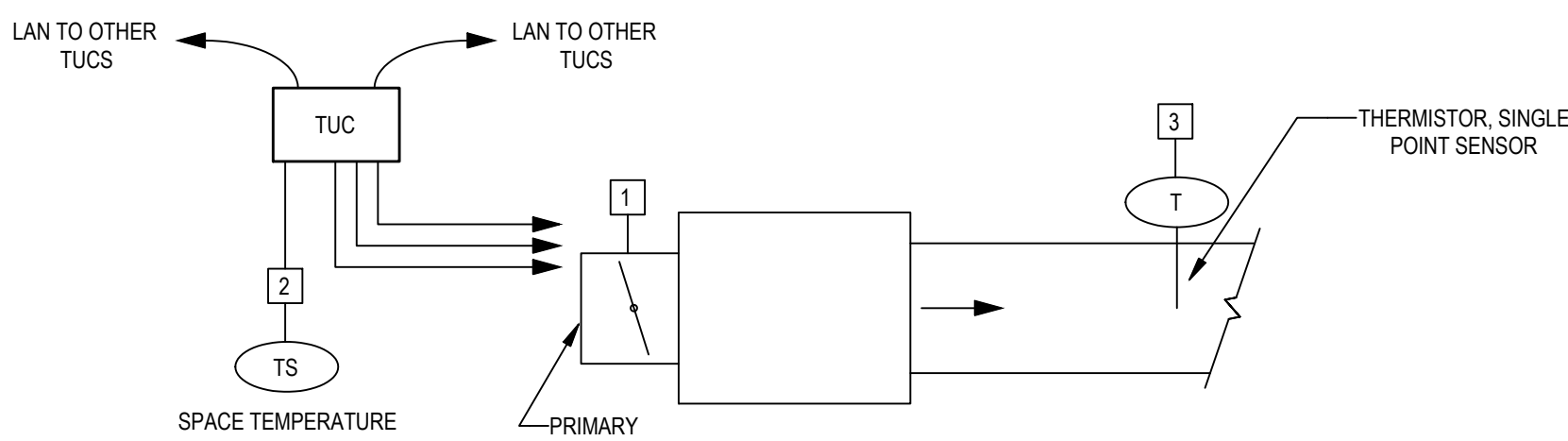


SEQUENCE OF OPERATION:
THE DISCHARGE AIR TEMPERATURE SENSOR SHALL BE USED FOR INDICATION ONLY.
SEPARATE HEATING AND COOLING SETPOINT CAPABILITY SHALL BE PROVIDED. WHEN THE SPACE TEMPERATURE FALLS BETWEEN THE HEATING AND COOLING SETPOINTS, NO HEATING OR COOLING ENERGY SHALL BE PROVIDED. THE PRIMARY AIR VALVE SHALL REMAIN AT ITS MINIMUM POSITION.
UNOCCUPIED MODE:
DURING THE UNOCCUPIED MODE OF OPERATION, THE TERMINAL UNIT SHALL CONTROL, AS DURING THE OCCUPIED MODE EXCEPT THAT THE COOLING TEMPERATURE SETPOINT SHALL BE 80°F (ADJUSTABLE) AND THE HEATING TEMPERATURE SETPOINT SHALL BE 65°F (ADJUSTABLE). THE SETUP AND SETBACK TEMPERATURES SHALL BE ADJUSTABLE. NO HEATING OR COOLING ENERGY SHALL BE UTILIZED BETWEEN THE HEATING AND COOLING SETPOINT TEMPERATURES EXCEPT THAT PROVIDED BY THE MINIMUM PRIMARY AIR FLOW. DURING THE TRANSITION FROM OCCUPIED TO UNOCCUPIED MODES, SPACE TEMPERATURE SHALL BE ALLOWED TO "FLOAT" FROM THE OCCUPIED TO THE UNOCCUPIED SPACE TEMPERATURE SETPOINTS WITHOUT THE ADDITION OF ANY HEATING OR COOLING ENERGY EXCEPT THAT PROVIDED BY THE MINIMUM PRIMARY AIR FLOW.
OCCUPIED MODE:
ON A FALL IN SPACE TEMPERATURE TOWARD SETPOINT (73°F +/- 2°F, ADJUSTABLE), THE PRIMARY AIR VALVE [1] SHALL BE MODULATED TOWARD ITS MINIMUM POSITION. ON A FURTHER FALL IN SPACE TEMPERATURE BELOW SETPOINT AND AFTER THE TEMPERATURE HAS PASSED THROUGH AN ADJUSTABLE DEADBAND, THE PRIMARY AIR QUANTITY SHALL REMAIN CONSTANT AND THE HEATING VALVE [2] SHALL OPEN A PROPORTIONATE AMOUNT. ON A RISE IN SPACE TEMPERATURE TOWARD SETPOINT, THE REVERSE SEQUENCE SHALL OCCUR.

4 VAV TERMINAL BOX w/ HEATING AT MINIMUM PRIMARY AIRFLOW CONTROLS DETAIL
SCALE: NONE

BAS POINTS LIST								
		GRAPHIC	ANALOG		DIGITAL			
TAG	NAME/FUNCTION		AI	AO	DI	DO	REMARKS	QTY
	VAV SYSTEM	●						
1	VAV PRIMARY AIR VALVE			●			-	1
2	DISCHARGE AIR TEMPERATURE SENSOR		●				-	1
3	SPACE TEMPERATURE SENSOR		●				SEE NOTE 1	1
4	COOLING SETPOINT		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
5	HEATING SETPOINT		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
6	CFM		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
7	MIN CFM		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
8	MAX CFM		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
9	UNOCCUPIED COOLING SETPOINT		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
10	UNOCCUPIED HEATING SETPOINT		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
11	VALVE OVERRIDE		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
12	HEAT OVERRIDE		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
13	MAX ZONE TEMP GROUP		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
14	MIN ZONE TEMP GROUP		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
15	AVERAGE ZONE TEMP GROUP		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A
16	TOTAL GROUP FLOW		N/A	N/A	N/A	N/A	PROGRAMMABLE SOFTWARE POINT	N/A

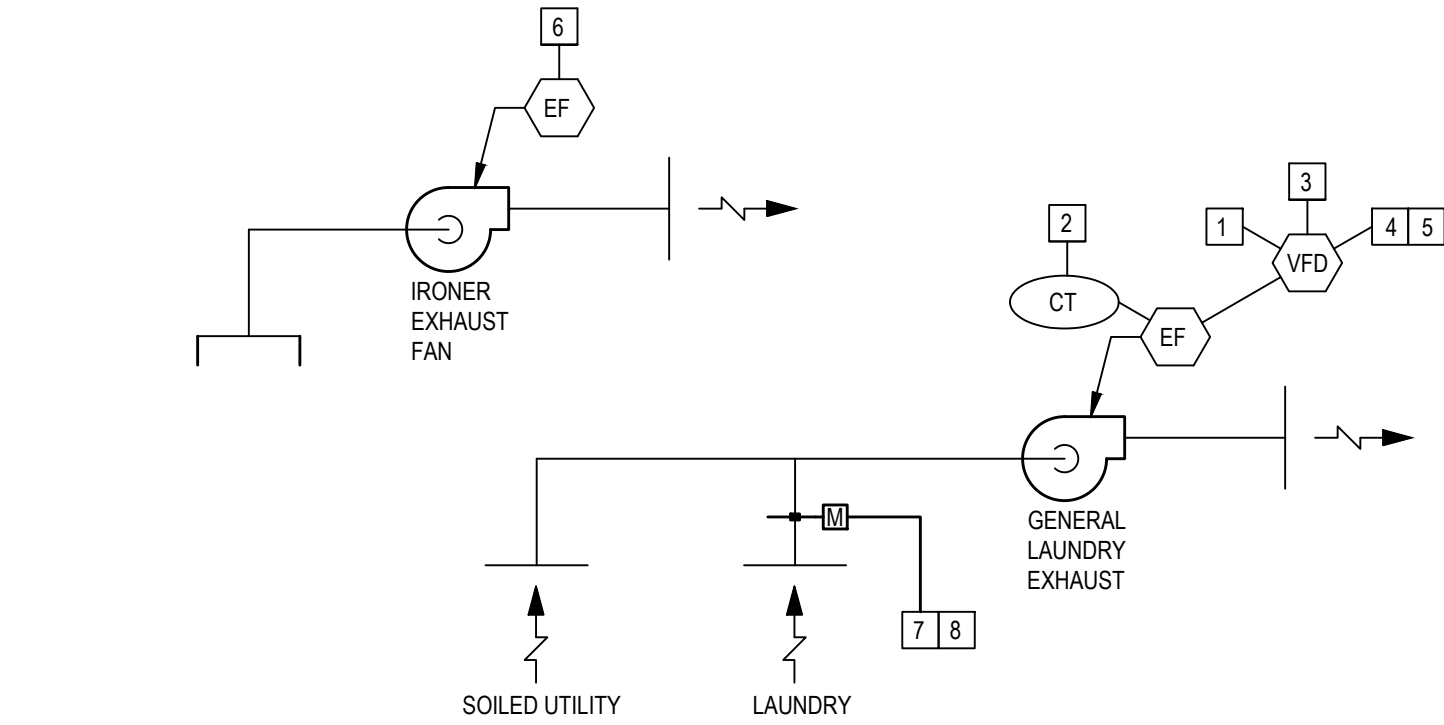
- NOTES:
1. HIGH AND LOW TEMP ALARMS AT BAS FOR CRITICAL SPACES (TELECOM, ELECTRICAL, COMPUTER ROOM)
2. PROVIDE TREND DATA FOR ALL POINTS SHOWN. TRENDING DATA SHALL BE STORED USING NON-VOLATILE MEMORY WITHIN THE BAS. DATA SHALL BE RECORDED AT A MINIMUM OF EVERY 15 MINUTES AND KEPT FOR A PERIOD OF A MINIMUM OF 12 MONTHS. THE CONTROL SYSTEM SHALL ALSO BE CAPABLE OF PROVIDING CUSTOM EXPORTS BASED ON SELECTED POINTS AND TIME FRAMES AND EXPORTS SHALL BE PROVIDED IN CSV OR XLS FILE FORMAT.



SEQUENCE OF OPERATIONS
ON A FALL IN SPACE TEMPERATURE TOWARD SETPOINT (73°F +/- 2°F, ADJUSTABLE), THE PRIMARY AIR VALVE [1] SHALL BE MODULATED TOWARD ITS MINIMUM POSITION. ON A FURTHER FALL IN SPACE TEMPERATURE BELOW SETPOINT, THE PRIMARY AIR QUANTITY SHALL REMAIN CONSTANT TO PROVIDE VENTILATION AIRFLOW TO THE SPACE. ON A RISE IN SPACE TEMPERATURE ABOVE SETPOINT, THE BASEBOARD HEATER SHALL BE DE-ENERGIZED ON A RISE IN SPACE TEMPERATURE ABOVE SETPOINT (73°F +/- 2°F, ADJUSTABLE), THE PRIMARY AIR VALVE [1] SHALL BE MODULATED TOWARD ITS MAXIMUM POSITION. THE DISCHARGE AIR TEMPERATURE SENSOR SHALL BE USED FOR INDICATION ONLY.

3 VAV TERMINAL BOX (COOLING ONLY) CONTROLS DETAIL
SCALE: NONE

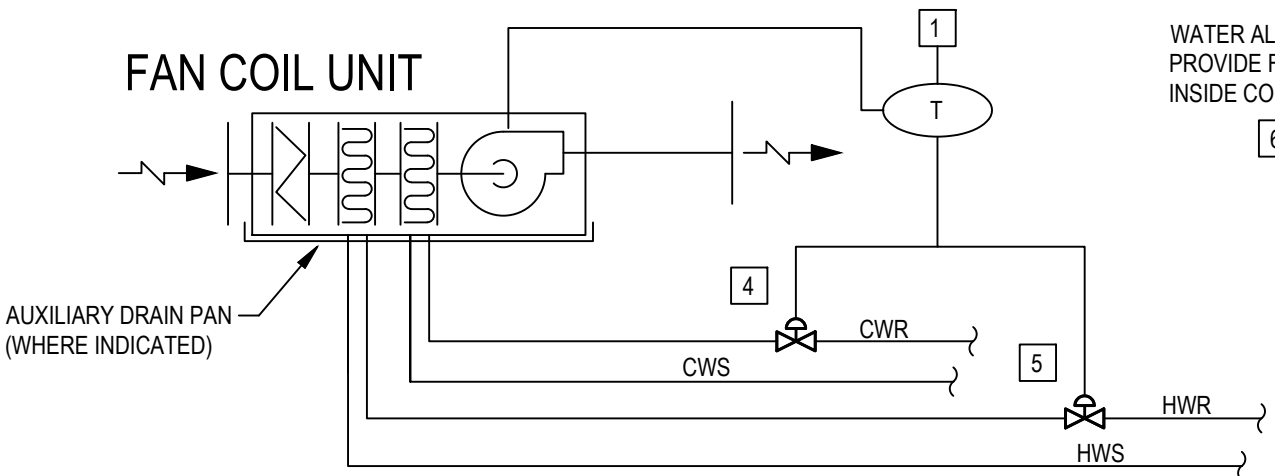
BUILDING CONTROL PANEL POINTS LIST									
TAG	NAME/FUNCTION	GRAPHIC	ANALOG		DIGITAL		REMARKS		QTY
			AI	AO	DI	DO			
	EXHAUST FAN	●					DIAGRAMMATIC SYSTEM GRAPHIC		
1	EXHAUST FAN ON/OFF				●		-	AS SHOWN ON PLANS	
2	EXHAUST FAN STATUS				●		-	AS SHOWN ON PLANS	
3	EXHAUST FAN SPEED			●					
4	EXHAUST FAN VFD FEEDBACK	●							
5	EXHAUST FAN VFD ALARM				●				
6	IRONER STATUS				●				
7	DAMPER COMMAND			●					
8	DAMPER POSITION	●							



SEQUENCE OF OPERATION
EXHAUST FAN [1] SHALL RUN CONTINUOUSLY TO MAINTAIN MINIMUM EXHAUST AIR CHANGE RATE PRESCRIBED BY FCU (1900 CFM). SYSTEM IS EQUIPPED WITH FAN SPEED CONTROL AND MODULATING LAUNDRY EXHAUST DAMPER TO REDUCE GENERAL EXHAUST WHEN 1450 CFM IRONER EXHAUST FAN IS OPERATING. MONITOR STATUS OF IRONER EXHAUST FAN [6] UPON INDICATION OF IRONER EXHAUST FAN OPERATION, PARTIALLY SHUT LAUNDRY MOTORIZED DAMPER [7], MONITOR POSITION FEEDBACK [8] AND GENERATE ALARM IN THE POSITION DOES NOT MATCH COMMAND. COORDINATE WITH TAB CONTRACTOR DURING CLOSE-OUT TESTING AND BALANCING TO DETERMINE DAMPER POSITION SETTING [7] AND FAN SPEED SETTING [3] REQUIRED TO MAINTAIN TOTAL LAUNDRY AIR CHANGE RATES AND SOILED UTILITY EXHAUST RATES DURING BOTH IRONER OFF AND IRONER ON CONDITIONS.

2 EXHAUST FAN CONTROLS DETAIL
SCALE: NONE

BAS POINTS LIST								
		GRAPHIC	ANALOG		DIGITAL			
TAG	NAME/FUNCTION		AI	AO	DI	DO	REMARKS	QTY
	FAN COIL UNIT	●					DIAGRAMMATIC SYSTEM (GRAPHIC FOR EACH UNIT)	
1	SPACE TEMPERATURE SENSOR		●					AS SHOWN ON PLANS
2	FAN ON/OFF					●		AS SHOWN ON PLANS
3	FAN STATUS				●			AS SHOWN ON PLANS
4	CHILLED WATER VALVE			●				AS SHOWN ON PLANS
5	HOT WATER VALVE			●				AS SHOWN ON PLANS
6	WATER ALARM				●		AS SHOWN ON PLANS	



SEQUENCE OF OPERATION
THE LOCAL THERMOSTAT SHALL CYCLE UNIT FAN, CHILLED WATER CONTROL VALVE AND HOT WATER CONTROL VALVE AS NEEDED TO MAINTAIN SPACE TEMPERATURE COOLING/HEATING SETPOINT (ADJ.). ON A FALL IN SPACE TEMPERATURE BELOW THE HEATING SETPOINT (70°F ADJ.), THE HOT WATER VALVE [5] SHALL OPEN A PROPORTIONATE AMOUNT. ON A RISE IN SPACE TEMPERATURE TOWARD SETPOINT, THE REVERSE SEQUENCE SHALL OCCUR. ON A RISE IN SPACE TEMPERATURE ABOVE THE COOLING SETPOINT (75°F ADJ.), THE CHILLED WATER VALVE [4] SHALL OPEN A PROPORTIONATE AMOUNT. ON A RISE IN SPACE TEMPERATURE TOWARD SETPOINT, THE REVERSE SEQUENCE SHALL OCCUR. SETPOINT ADJUSTMENT SHALL BE AVAILABLE THROUGH THE BAS.
SEPARATE HEATING AND COOLING SETPOINT CAPABILITY SHALL BE PROVIDED. WHEN THE SPACE TEMPERATURE FALLS BETWEEN THE HEATING AND COOLING SETPOINTS (ADJUSTABLE DEADBAND), NO HEATING OR COOLING ENERGY SHALL BE PROVIDED. THE FCU SHALL BE DE-ENERGIZED.
FOR FAN COIL UNITS WITH AN AUXILIARY DRAIN PAN, IF WATER SENSOR [6] DETECTS PRESENCE OF WATER BELOW UNIT, THE CONTROL SYSTEM SHALL GENERATE AN ALARM TO THE OPERATOR WORKSTATION, FULLY CLOSE THE CHILLED WATER VALVE, FULLY CLOSE THE HOT WATER VALVE AND DE-ENERGIZED THE SUPPLY FAN.

1 FAN COIL CONTROLS DETAIL
SCALE: NONE

ST+B ENGINEERING
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MEMORIAL HOSPITAL OF
SWEETWATER COUNTRY
LAUNDRY RENOVATION
1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

ST+B PROJECT NO.: 2645.24

NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	6/1/2026

SHEET NAME
MECHANICAL
CONTROLS

SHEET NO.
M600

GENERAL REQUIREMENTS:

- AS THE SIGNATORY ON THE PRIME CONSTRUCTION AGREEMENT, THE CONSTRUCTION MANAGER AT RISK (CMAR) AND/OR GENERAL CONTRACTOR (GC) IS RESPONSIBLE FOR ALL WORK INDICATED IN THE CONTRACT DOCUMENTS. GC MAY ASSIGN WORK THROUGH SUB-CONTRACTS AT THEIR DISCRETION, PROVIDED THEY UTILIZE TRANSFERABLE THAT ARE FULLY QUALIFIED, LICENSED, EXPERIENCED, AND KNOWLEDGEABLE IN THEIR RESPECTIVE AREAS OF THE CONSTRUCTION INDUSTRY. SUB-CONTRACTORS SHALL PERFORM WORK IN A RESPONSIBLE MANNER WITH ESTABLISHED CONSTRUCTION PRACTICE AND AS CALLED FOR IN THE PERTINENT SPECIFICATION SECTION(S). COORDINATION WITH ANY WORK SHOWN IN OTHER TRADES INVOLVED IN THIS PROJECT REMAINS A RESPONSIBILITY OF THE GC IN ORDER TO PROPERLY SEQUENCE EFFORTS.
- ALL WORK, MATERIALS, AND TRADES SHALL FOLLOW THE LATEST ADOPED EDITIONS OF THE NATIONAL FIRE PROTECTION ADMINISTRATION (NFPA) AND INTERNATIONAL CODE COUNCIL (ICC) STANDARDS FOR BUILDING CONSTRUCTION AND ENERGY USE. REFER TO ARCHITECTURAL CODE SHEET FOR ADDITIONAL INFORMATION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PERFORM WORK IN CONFORMANCE WITH ALL APPLICABLE CODES, ORDINANCES, AND LIFE SAFETY MEASURES AS REQUIRED BY LOCAL, STATE, AND NATIONAL AUTHORITIES. CONSULT LITERATURE AND WEBSITES OF JURISDICTIONAL AUTHORITIES FOR ANY AMENDMENTS OR ADDITIONAL REQUIREMENTS.
- ALL MATERIALS SHALL BE NEW AND LISTED FOR THE APPLICATION UNLESS OTHERWISE NOTED. EQUIPMENT SHALL BE SET STRAIGHT AND SQUARE WITH THE STRUCTURE. CONDUIT SHALL BE INSTALLED PARALLEL OR AT RIGHT ANGLES TO ALL WALLS AND STRUCTURAL MEMBERS. HANGER RODS, EQUIPMENT BASES, SUPPORTS, AND ISOLATION SHALL BE SET PLUMB AND SQUARE AND IN VERTICAL ALIGNMENT WHERE APPLICABLE. ALL WORK SHALL BE NEAT AND CLEAN UPON COMPLETION. ALL WORK SHALL BE PERFORMED IN A WORKMANLIKE MANNER TO THE SATISFACTION OF THE OWNER AND ENGINEER.
- CONTRACTOR IS RESPONSIBLE FOR A COMPLETE AND OPERATIONAL INSTALLATION OF ALL SYSTEMS DEPICTED WITHIN THESE CONTRACT DOCUMENTS, ALONG WITH STARTUP AND COMMISSIONING AS DESCRIBED IN THE SPECIFICATIONS. REASONABLE ASSUMPTIONS SHALL BE MADE FOR ANY ASPECT NOT COMPLETELY DETAILED WITHIN AND ALL LABOR AND MATERIALS CONTAINED IN THE FINAL BID PRICE. THE CONTRACTOR SHALL ASSURE AND DEMONSTRATE PROPER OPERATION OF ALL DESCRIBED SYSTEMS AND EQUIPMENT TO THE OWNER PRIOR AS PART OF SUBSTANTIAL COMPLETION.
- ALL DRAWINGS AND SPECIFICATIONS ARE TO BE READ IN COORDINATION WITH ONE ANOTHER SUCH THAT WORK SHOWN ON ONE SET IS BINDING TO THE OTHER. WHERE A DISCREPANCY EXISTS WITHIN THESE CONTRACT DOCUMENTS, THE SPECIFICATIONS SHALL TAKE PRECEDENCE. WHERE A DISCREPANCY EXISTS WITHIN THE SPECIFICATION, CONTRACTOR SHALL PRICE THE MORE EXPENSIVE APPROACH, AND THE DETAILS SHALL BE WORKED OUT DURING CONSTRUCTION.
- THESE DRAWINGS AND SPECIFICATIONS ARE NOT A DETAILED SET OF INSTALLATION INSTRUCTIONS BUT RATHER A GUIDELINE TO ESTABLISH QUALITY OF EQUIPMENT AND MATERIALS, LEVEL OF WORKMANSHIP, AND PERFORMANCE. DO NOT SCALE DRAWINGS. VERY DIMENSIONS WITH SHOP DRAWINGS COORDINATION EFFORT AND IN THE FIELD PRIOR TO COMMENCEMENT OF WORK.
- CONTRACTOR SHALL BE RESPONSIBLE TO REPAIR, UP TO A LIKE-NEW CONDITION, ANY AND ALL DAMAGES CAUSED TO EXISTING EQUIPMENT AND/OR ADJACENT STRUCTURES. ALL REPAIRED SURFACES SHALL BE INDISTINGUISHABLE FROM THE EXISTING ADJACENT SURFACES. PROVIDE A DETAILED LIST OF ALL EXISTING DAMAGED ITEMS AND SUBMIT TO OWNER PRIOR TO BEGINNING WORK. ITEMS NOT DOCUMENTED BECOME A RESPONSIBILITY OF THE CONTRACTOR.
- THE CONTRACTOR SHALL REMOVE AND PROPERLY DISPOSE OF ALL DEBRIS AND SHALL CLEAN ALL EQUIPMENT AND AREAS AFFECTED BY CONTRACTOR'S WORK AT THE END OF EACH SHIFT EACH DAY. DISPOSAL OF ALL MATERIALS SHALL BE AS DIRECTED BY THE DIVISION J SPECIFICATIONS.
- SYMBOLS, ABBREVIATIONS, AND DEVICES IN THE LEGENDS ARE GENERAL. FOR EXACT REQUIREMENTS, REFER TO THE SCHEDULES, LAYOUTS, DETAILS, AND TO THE SPECIFICATIONS SINCE THE APPEARANCE OF A PARTICULAR ITEM IN THE LEGEND DOES NOT NECESSARILY IMPLY THAT THE ITEM IS INCLUDED AS A REQUIREMENT OF THE DESIGN.
- ALL PENETRATIONS FOR RACEWAY AND CABLE THAT ARE BY THIS CONTRACTOR AND WHICH PENETRATE FLOORS, FIRE AND/OR SMOKE BARRIERS, AND SEPARATIONS SHALL BE SEALED WITH A SYSTEM SPECIFICALLY UL APPROVED FOR THE APPLICATION.
- EXPPOSED CONDUIT SHALL BE HELD TO THE ABSOLUTE MINIMUM. ANY PATHWAYS IN PUBLIC OR COMMON AREAS NEED WRITTEN APPROVAL OF THE ENGINEER PRIOR TO INSTALLATION. ANY EXPPOSED CONDUIT SHALL BE PAINTED TO MATCH THE ADJACENT FINISHES WITHIN ITS SURROUNDING AREA.
- ALL NEW FEEDER, HOMERUN, AND BRANCH CIRCUITS SHALL BE INSTALLED WITH A SEPARATE INSULATED GROUND CONDUCTOR. ANY EXISTING NON-INSULATED WIRING CURRENTLY BEING USED AS GROUNDING PATH AND PART OF THE SCOPE OF THIS PROJECT SHALL BE PROVIDED WITH NEW GROUND WIRE.

COORDINATION NOTES:

- THIS SHEET IS PART OF A COMPREHENSIVE SET OF DESIGN DRAWINGS AND SPECIFICATIONS THAT INCLUDE OTHER ENGINEERING, ARCHITECTURAL, AND DESIGN DISCIPLINES. INSTALLING CONTRACTOR SHALL BE RESPONSIBLE TO REVIEW THE FULL SET OF CONTRACT DOCUMENTS, INCLUDING ALL DRAWINGS, SPECIFICATIONS, AND ADDENDA, IN CONJUNCTION WITH THE DESIGN PACKAGE TO PROVIDE AN EFFICIENTLY SEQUENCED AND FULLY COORDINATED INSTALLATION. PROVIDE COORDINATION DRAWINGS PER SPECIFICATIONS. CONTRACTOR BEARS THE RESPONSIBILITY TO PROVIDE ANY ADDITIONAL LABOR AND MATERIALS THAT RESULT FROM A LACK OF INTERDISCIPLINARY COORDINATION.
- ITEMS SPECIFIED HEREIN BY MANUFACTURER AND MODEL NUMBER ARE TO BE CONSIDERED THE MINIMUM QUALITY ACCEPTABLE FOR THE SPECIFIED APPLICATION. FOR SUBSTITUTIONS, IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE SUFFICIENT INFORMATION TO THE DESIGN TEAM IN ORDER TO ESTABLISH "OR EQUAL" STATUS AND TO COORDINATE INSTALLATION OF SAME INTO THE AVAILABLE SPACE. INCREASED COSTS TO THE PROJECT ASSOCIATED WITH CONTRACTOR SUBSTITUTIONS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. SUBSTITUTIONS FOR CONVENIENCE WILL NOT BE CONSIDERED PER THE GENERAL REQUIREMENTS OF THE CONTRACT.
- COORDINATE AND SCHEDULE ALL EQUIPMENT SHUTDOWNS AND ELECTRICAL OUTAGES WITH OWNER AND DESIGN TEAM. PROVIDE A MINIMUM SEVEN (7) CALENDAR DAYS' NOTICE WHERE OUTAGE AFFECTS BUILDING LIFE SAFETY SYSTEMS. CONTRACTOR SHALL PREPARE AND SUBMIT A WRITTEN METHOD OF PROCEDURES.
- FURNISH ALL NECESSARY SLEEVES, FLASHINGS, COUNTER FLASHINGS, INSERTS, ANCHOR BOLTS, EQUIPMENT SUPPORTS, ETC. TO INSTALLING CONTRACTOR IN A TIMELY FASHION WHERE REQUIRED TO COMPLETE THE WORK. THIS SHALL INCLUDE ANY AND ALL CAULKING, PATCHING, CUTTING, ETC. AS REQUIRED THROUGH ANY ROOF, FLOOR, AND/OR WALL SYSTEMS.
- EQUIPMENT SHALL FIT INTO THE SPACE ALLOTTED/INDICATED AND SHALL ALLOW ADEQUATE CLEARANCE FOR ENTRY, INSTALLATION, REPLACEMENT, SERVICING, AND MAINTENANCE. COORDINATE ALL EQUIPMENT WITH WORK BY OTHER TRADES. INSTALLATION SHALL COMPLY WITH MANUFACTURER'S INSTRUCTIONS AND ALL APPLICABLE CODES. CLEARANCES SHALL COMPLY WITH NEC. ALL ADDITIONAL WORK REQUIRED FOR EQUIPMENT PROPOSED BY THE CONTRACTOR SHALL BE IDENTIFIED ON EQUIPMENT SUBMITTALS FOR REVIEW BY THE EOR PRIOR TO PURCHASE AND SHALL BE PROVIDED AT NO ADDITIONAL COSTS.
- DO NOT CUT, CORE, AFFIX TO, OR MODIFY ANY STRUCTURAL OR BUILDING ELEMENTS WITHOUT RECEIVING PRIOR APPROVAL FROM THE ENGINEER OR ARCHITECT INVOLVED.
- THE CONTRACTOR SHALL MAINTAIN AN ACCURATE SET OF RECORD DRAWINGS ON-SITE AT ALL TIMES DURING CONSTRUCTION WHICH SHALL BE AVAILABLE FOR EXAMINATION BY THE OWNER'S REPRESENTATIVE UPON REQUEST. PROVIDE THE OWNER WITH A COMPLETE MARKED-UP SET OF AS-BUILT CONTRACT DRAWINGS AT PROJECT COMPLETION. REFER TO SPECIFICATIONS FOR ADDITIONAL RECORD DRAWING REQUIREMENTS.

DEMOLITION NOTES:

- CONTRACTOR SHALL MAKE ARRANGEMENTS WITH OWNER AND/OR ARCHITECT TO VISIT SITE AND CONDUCT WITH CONTRACTORS PRIOR TO SUBMITTING A COST PROPOSAL TO ENSURE THE TRADES ARE FAMILIAR WITH THE SPECIFIC CONDITIONS GOVERNING THIS PROJECT SCOPE. PAY PARTICULAR ATTENTION TO SCOPE AREAS AS THEY RELATE TO EXISTING SYSTEMS AND ANY PHASING INDICATED. FIELD VERIFY EXACT EXTENT OF DEMOLITION WORK. NO EXTRAS WILL BE CONSIDERED FOR WORK REQUIRED TO ACHIEVE THE INTENT OF THESE CONTRACT DOCUMENTS. NOTIFY DESIGN TEAM OF ANY DISCREPANCIES FOR RESOLUTION AS SOON AS DISCOVERED.
- EXISTING CONDITIONS SHOWN ON THESE PLANS REPRESENT LISTED FIELD OBSERVATIONS MADE BY ST+B ENGINEERING. ROUTING, HIDDEN CONDITIONS, AND CONFORMANCE TO CURRENT PREVAILING CODES HAS NOT BEEN VERIFIED. DESIGN TEAM SHALL NOT BE RESPONSIBLE FOR THE ACCURACY AND/OR SAFETY OF CONDITIONS INDICATED AS EXISTING.
- DEMOLITION ITEMS SHALL BE REMOVED COMPLETELY, INCLUDING ALL CONNECTIONS, MOUNTING, PATHWAYS, SUPPORTS, AND WIRING. CIRCUIT SHALL BE REMOVED BACK TO LAST ACTIVE BRANCH, DEVICE, OR PANEL, UNLESS SPECIFICALLY NOTED FOR REUSE OR TO BE TURNED OVER TO OWNER. CONTRACTOR SHALL HAVE RESPONSIBILITY TO PROPERLY RECYCLE AND/OR DISPOSE OF ALL REMOVED ITEMS. DO NOT BURN OR BURY.
- EXISTING CONDUITS MAY BE REUSED WHERE THEY COMPLY WITH THE REQUIREMENTS OF THESE SPECIFICATION, WIRING AND PATHWAY EXTENSIONS SHALL BE NEW. DO NOT REINSTALL ANY CONDUIT WHICH IS REMOVED OR DEMOLISHED. PATHWAYS ROUTING WITHIN OR PASSING THROUGH CONCRETE FLOOR SLABS SHALL BE CUT BACK TO JUST BELOW CONCRETE AND FILLED WITH GROUT. FINISH TO ACHIEVE A SMOOTH AND EVEN SURFACE FLUSH WITH SURROUNDING CONCRETE. ALL PATHWAYS, NEW AND EXISTING UNDER THIS CONTRACT, SHALL BE LABELED PER THE SPECIFICATIONS.
- ALL WALLS SHALL BE PROPERLY PATCHED AND REPAINTED AFTER THE REMOVAL OF DEVICES. REPAIR TO A LEVEL OF FINISH CONSISTENT WITH THE ADJACENT SURFACES. BLANK COVER PLATES OVER EXISTING BOXES ARE NOT ACCEPTABLE, UNLESS NOTED OTHERWISE.
- RE-SUPPORT AND SECURE EXISTING RACEWAYS/CONDUITS ASSOCIATED WITH SCOPE OF WORK TO COMPLY WITH CURRENT ADOPTED REQUIREMENTS OF NFPA 70, CHAPTER 3.
- MAINTAIN CIRCUIT CONTINUITY TO EXISTING CIRCUITS AND DEVICES TO REMAIN. REWORK EXISTING WIRING, BOXES, TERMINATIONS, ETC. AS REQUIRED TO INTERFACE NEW WORK SHOWN.
- WHERE THE REMOVAL OF A SURFACE MOUNTED RACEWAY/DEVICE LEAVES VISIBLE EVIDENCE ON AN EXISTING SURFACE NOT SCHEDULED FOR DEMOLITION OR REWORK, THE SURFACE SHALL BE REPAIRED OR REPLACED TO A QUALITY EQUAL TO FINAL SCHEDULED FINISH OF ADJACENT SURFACES. WHERE THE EXISTING RACEWAY IS CONCEALED IN ASSEMBLIES NOT SCHEDULED FOR DEMOLITION THE OUTLET BOX SHALL BE CLEANED, AND A BLANK COVER-PLATE INSTALLED.

LIGHTING NOTES:

- REFER TO ARCHITECTURAL REFLECTED CEILING PLANS, SECTIONS, AND ELEVATIONS FOR EXACT LOCATION OF INTERIOR LIGHTING. ALL LOCATIONS SHALL BE COORDINATED WITH PLANS AND IMPEDIMENTS OF OTHER TRADES PRIOR TO ROUGH-IN. REFER TO SPECIFICATIONS FOR COORDINATION DRAWING REQUIREMENTS.
- LIGHT FIXTURES DESIGNATED AS "EMERGENCY" ARE INDICATED IN DRAWINGS AS SHADERS AND SHALL BE WIRED WITH A UL RELAY TO OPERATE WITH LOCAL SWITCHING UNDER NORMAL CONDITIONS AND SHALL OPERATE VIA BATTERY OR GENERATOR LIFE SAFETY POWER AT FULL OUTPUT REGARDLESS OF CONTROLS STATE UPON LOSS OF BUILDING UTILITY POWER ONLY, UNLESS NOTED OTHERWISE.
- EXIT SIGNS SHALL BE WIRED AHEAD OF LOCAL SWITCHING FOR CONTINUOUS OPERATION. EXIT SIGNS SHALL BE CEILING MOUNTED OR WALL MOUNTED ABOVE DOORS WHERE PRACTICAL. PROVIDE ADDITIONAL EXIT SIGNS AS NECESSARY FOR APPROVAL BY THE AUTHORITY HAVING JURISDICTION. PER ARCHITECT'S FINAL PLAN OF EGRESS / EXITTING PLAN.
- LIGHTING CONTROLS SEQUENCE OF OPERATION IS DEFINED FOR EACH SPACE IN THE LIGHTING CONTROL SCHEDULE. CONTRACTOR SHALL BE RESPONSIBLE FOR FINAL LIGHTING DEVICE QUANTITIES AND LOCATIONS WITH SUBMITTED LIGHTING CONTROL MANUFACTURERS SHOP DRAWINGS AFTER THE LIGHTING CONTROLS SUBMITTAL HAS BEEN REVIEWED WITH NO EXCEPTIONS TAKEN BY THE ENGINEER OF RECORD.
- LIGHTING CONTROL WIRING DETAILS ARE DIAGRAMMATIC IN NATURE AND ARE ONLY INTENDED TO ILLUSTRATE THE GENERAL REQUIREMENTS OF THE LIGHTING CONTROL SYSTEM FOR COMPLIANCE WITH ADOPTED CODE. CONTROL SYSTEM MAY REQUIRE ADDITIONAL EQUIPMENT TO ACHIEVE DESIGN INTENT SHOWN IN DRAWINGS. CONTRACTOR SHALL COORDINATE WITH THE LIGHTING CONTROLS MANUFACTURER BEING SUBMITTED TO INSURE THE SYSTEM OPERATES TO THE DESIGN INTENT SPECIFIED WITHIN THESE DOCUMENTS.
- ONLY SENSORS AND SWITCHES SHALL BE VIEWABLE OR ACCESSIBLE TO THE PUBLIC. ALL OTHER LIGHTING CONTROL DEVICES SHALL BE CONCEALED FROM PUBLIC VIEW IN AN ACCESSIBLE LOCATION WITH THAT LOCATION MARKED BY A 3/4" DIAMETER, GREEN, CIRCULAR, ADHESIVE MARKER TO ASSIST MAINTENANCE STAFF WITH LOCATING THESE DEVICES.
- THE CONTRACTOR SHALL PROGRAM, TEST, AND COMMISSION THE LIGHTING CONTROL SYSTEM TO INSURE PERFORMANCE ADHERES TO THE DESIGN REQUIREMENTS SPECIFIED IN THESE DOCUMENTS AS WELL AS TESTING AND COMMISSIONING REQUIREMENTS DEFINED IN THE ENERGY CODE (IECC). CONTRACTOR SHALL PROVIDE A 3RD PARTY COMMISSION AGENT AS NECESSARY TO MEET IECC REQUIREMENTS.

POWER NOTES:

- ALL DEDICATED WORKING SPACES AS DEFINED IN THE NEC SHALL BE MARKED OUT AND FIELD PAINTED ON THE FLOOR BENEATH THE EQUIPMENT. PROVIDE A FOUR-INCH WIDE YELLOW AND BLACK OUTLINE OF THE WORKING SPACE. PERIMETER IN PAINT OR PERMANENT VINYL, FLOOR-MARKING TAPE.
- PANEL SCHEDULES SHALL BE FILLED OUT SO EVERY NEW AND/OR MODIFIED CIRCUIT IS UNIQUELY IDENTIFIED WITH ITS SPECIFIC PURPOSE AND/OR EQUIPMENT AS NECESSARY TO DISTINGUISH FROM ALL OTHER LOADS. IDENTIFICATION SHALL INCLUDE A DEGREE OF DETAIL AS APPROVED BY THE A/E.
- PROVIDE NYLON PULL ROPE FOR ALL SPARE CONDUITS AS WELL AS ANY PATHWAYS PROVIDED FOR OTHER TRADES SUCH AS CONTROLS OR TECHNOLOGY.
- INSTALL ALL CONDUIT GENERALLY IN THE ROUTES/AREAS SHOWN ON DRAWINGS. PROVIDE ADDITIONAL SUPPORT WHEREVER THE BUILDING STRUCTURE IS NOT SUITABLE FOR DIRECT MOUNTING. OFFSET CONDUIT, EQUIPMENT, ETC. AS NECESSARY TO ACCOMMODATE STRUCTURE, BEAMS, COLUMNS, OTHER SYSTEMS IN THIS TRADE AND OTHER TRADES. CONDUIT OR EQUIPMENT THAT IS NOT INSTALLED PROPERLY OR WITHIN THE SPACE PROVIDED SHALL BE REMOVED AND REINSTALLED AT NO EXTRA COST.
- ANY ADJACENT DEVICES, AS WELL AS ALL DEVICES LOCATED ABOVE A COUNTER, SHALL BE MOUNTED AT THE SAME ELEVATION UNLESS OTHERWISE NOTED. THIS INCLUDES RECEPTACLES, SWITCHES, ETC. COUNTER RECEPTACLES SHALL BE MOUNTED HORIZONTALLY ABOVE THE BACK SPLASH. DO NOT CUT DEVICE PLATES.
- COORDINATE FINAL RECEPTACLE LOCATIONS WITH TELECOM OUTLETS PRIOR TO ROUGH-IN. EACH OUTLET SHALL BE LOCATED WITHIN ADJACENT STUD BAYS, AT A MINIMUM, COORDINATE FINAL LOCATIONS WITH CASEWORK AND ARCHITECTURAL PLANS PRIOR TO ROUGH-IN.
- DO NOT INSTALL FLUSH-MOUNTED BOXES ON OPPOSITE SIDES OF WALLS BACK-TO-BACK. PROVIDE MINIMUM 12 INCHES HORIZONTAL SEPARATION UNLESS OTHERWISE INDICATED. FOR ACOUSTIC-RATED WALLS PROVIDE 24 INCHES SEPARATION. REFER TO ARCHITECTURAL DRAWINGS TO COORDINATE LOCATIONS OF ACOUSTIC-RATED WALLS.
- GFCI RESETS SHALL BE IN ACCESSIBLE LOCATIONS. PROVIDE GFCI BREAKER OR A REMOTE RESET WHERE RECEPTACLE IS LOCATED BEYOND THE EQUIPMENT.

TECHNOLOGY NOTES:

- ALL CABLES MUST BE TESTED AND LABELED PER EIA/TIA STANDARDS AND ALL HORIZONTAL LINKS SHALL BE A PARTNERED SOLUTION WITH A MINIMUM 25-YEAR WARRANTY.
- FOR WIRELESS ACCESS POINTS, CONTRACTOR SHALL INSTALL A TWO-PORT DATA OUTLET IN CEILING TILE WITH APPROPRIATE BOX SUPPORTED FROM STRUCTURE AND PROVIDE CABLEING BACK TO PATCH PANEL. WIRELESS ACCESS POINT AND POE SWITCH NOT IN CONTRACT.
- PROVIDE AN 8' SERVICE LOOP AT STATION END OF ALL CABLE RUNS. PROVIDE 15' SERVICE LOOP AT ALL WIRELESS ACCESS POINT LOCATIONS.
- PROVIDE DEEP 4" SQUARE OUTLET BOX WITH CABLE POSTS AND SINGLE GANG MUD RING FOR ALL INDIVIDUAL VOICE, DATA, OUTLET MATCH WALL PLATE AND JACK TO SYSTEM ROUTE 1/2 INCH CONDUIT TO 0.0 INCHES ABOVE ACCESSIBLE CEILING. PROVIDE INSULATED THROAT CONNECTOR ON CONDUIT END.
- ANY ADJACENT DEVICES AS WELL AS ALL DEVICES LOCATED ABOVE A COUNTER SHALL BE MOUNTED AT THE SAME ELEVATION UNLESS NOTED OTHERWISE. COUNTER DATA PORTS SHALL BE MOUNTED HORIZONTALLY ABOVE THE BACK SPLASH. DO NOT CUT DEVICE PLATES.
- COORDINATE FINAL RECEPTACLE LOCATIONS WITH TELECOM AND/OR AV OUTLETS PRIOR TO ROUGH-IN. EACH OUTLET SHALL BE LOCATED WITHIN ADJACENT STUD BAYS, AT A MINIMUM, COORDINATE FINAL LOCATIONS WITH CASEWORK AND ARCHITECTURAL PLANS PRIOR TO ROUGH-IN.
- DATA/COM CABLES MAY BE ROUTED OUT OF RACEWAY BETWEEN ABOVE ACCESSIBLE CEILINGS, BETWEEN CONDUIT SLUB AND CABLE TRAY. SUPPORT AND SECURE CABLES WITH U HOOKS AND RE-CLUSABLE HOOK-AND-LOOP STRAPS EVERY 30".
- COMMUNICATIONS CIRCUITS AND EQUIPMENT SHALL BE INSTALLED IN A NEAT AND PROFESSIONAL MANNER. CABLE MANAGEMENT, TRAYS, AND RACEWAYS SHALL BE SUPPORTED FROM BUILDING STRUCTURE AT APPROPRIATE INTERVALS.
- ANY CABLEING AND NON-METALLIC CABLES TIES AND ACCESSORIES, INSTALLED IN AIR PLENUMS, SHALL BE LOW SMOKE/HEAT RELEASE AND SHALL BE UL LISTED FOR USE IN THE ENVIRONMENT. ANY CABLEING NOT LISTED FOR PLENUM USE MUST BE INSTALLED IN CONDUIT.
- COORDINATE EXACT NUMBER OF CABLES AND ROUGH-IN LOCATIONS OF EQUIPMENT FURNISHED AND/OR INSTALLED BY OTHER SUB-CONTRACTORS THAT ALSO REQUIRE DATA CONNECTION, WITH THE CONTRACT DOCUMENT DRAWINGS AND SPECIFICATIONS, AS WELL AS THE GENERAL CONTRACTOR PRIOR TO ROUGH-IN OR ORDERING OF MATERIALS.
- COORDINATE EXACT NUMBER OF CABLES AND ROUGH-IN LOCATIONS OF EQUIPMENT FURNISHED AND/OR INSTALLED BY OTHER SUB-CONTRACTORS WITH THE FULL SET OF CONTRACT DOCUMENTS, SPECIFICATIONS, AND GENERAL CONTRACTOR PRIOR TO ROUGH-IN OR ORDERING OF MATERIALS.
- ALL MATERIALS PROVIDED FOR THE TELECOMMUNICATIONS AND SECURITY SYSTEMS SHALL BE COMPATIBLE WITH EXISTING SYSTEM HEAD END CONTROLLERS. COMPONENTS REQUIRED TO EXPAND THE EXISTING SYSTEMS CAPACITY SHALL BE PROVIDED BY BOTH THE CONTRACTOR AND OWNER. REFER TO RESPONSIBILITY MATRIX AND SPECIFICATIONS FOR ADDITIONAL DETAIL. ALL HORIZONTAL LINKS SHALL BE A PARTNERED SOLUTION WITH A MINIMUM 25-YEAR WARRANTY.

FIRE ALARM NOTES:

- FIRE ALARM LAYOUTS AND DEVICES INDICATED ON THESE PLANS DICTATE THE INTENT, PERFORMANCE, AND SCOPE OF THE SYSTEM. THE COMPLETE FIRE ALARM SYSTEM DESIGN SHALL BE PROVIDED AS A DEFERRED SUBMITTAL. PER THE REQUIREMENTS OF IECC/FBC, PROVIDE APPROPRIATE SHOP DRAWINGS AND DESIGN SUBMITTALS FOR APPROVAL BY THE LOCAL FIRE DEPARTMENT AND/OR THE AUTHORITY HAVING JURISDICTION. THE ELECTRICAL ENGINEER OF RECORD LISTED ON THIS SET OF DRAWINGS WILL NOT BE RESPONSIBLE FOR SEALING AND SIGNING THE FIRE ALARM SYSTEM SHOP DRAWING SUBMITTALS PROVIDED BY THE CONTRACTOR. CONTRACTOR SHALL MAKE NECESSARY ARRANGEMENTS IN JURISDICTIONS WHERE THIS IS REQUIRED AND INCLUDE COSTS IN BID.
- PROVIDE UPDATED GRAPHIC ZONE MAP AT REMOTE ANNUNCIATORS AND FIRE ALARM CONTROL UNITS AS SHOWN AND REQUIRED. SUBMIT SHOP DRAWINGS AND LOCATIONS TO ENGINEER AND BUILDING/FIRE DEPARTMENTS FOR REVIEW PRIOR TO INSTALLATION. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
- LOCATE SMOKE DETECTORS PER NFPA 72 AND MANUFACTURERS REQUIREMENTS. THE LOCATIONS OF SMOKE DETECTORS ON THE DRAWINGS ARE DIAGRAMMATIC ONLY. DETECTORS SHALL NOT BE PLACED WITHIN 3'-0" OF ANY CEILING MOUNTED HVAC SUPPLY AIR DEVICE, WITHIN 4' OF WALL, WHEN WALL MOUNTED. DETECTORS SHALL BE LOCATED BETWEEN 4" AND 12" FROM THE CEILING PLANE. DETECTORS FOR DAMPER CONTROL SHALL BE LOCATED NOT MORE THAN 5 FT HORIZONTALLY FROM THE FIS OR SMOKE DAMPER ASSEMBLY AND PRIOR TO ANY OUTLET DEVICE.
- CONTRACTOR SHALL RE-CERTIFY SYSTEM AND PROVIDE AN UPDATED RECORD OF COMPLETION WITH THE O&M MANUALS AT PROJECT CLOSEOUT.
- WIRING FOR POWER SUPPLIES AND AUXILIARY DEVICES USED FOR FIRE SAFETY FUNCTIONS SHALL BE MONITORED FOR INTEGRITY.
- NEW DEVICES SHALL BE INSTALLED AT HEIGHTS/ORIENTATIONS AS REQUIRED TO COMPLY WITH CURRENT ADOPTED IFC, NFPA 70/2, AND ADAS DOCUMENTS. EXTEND RACEWAY AND CABLEING AS NECESSARY FOR A COMPLETE AND OPERATIONAL SYSTEM.
- NEW FIRE ALARM DEVICES SHALL MATCH AND/OR BE COMPATIBLE WITH EXISTING FIRE ALARM SYSTEM MAIN CONTROL PANEL (FACP). PROVIDE RE-PROGRAMMING OF HEAD END AS REQUIRED TO ACCOMMODATE NEW DEVICES. REVISE EXISTING ANNUNCIATOR(S) AND/OR DEVICE MAP(S) TO REFLECT PROJECT FIRE ALARM AND ARCHITECTURAL MODIFICATIONS. UPDATE GRAPHIC ZONE MAPS IN BOTH THE FACILITY MAINTENANCE BUILDINGS AND IN THESE BUILDINGS AS REQUIRED. SUBMIT TO ENGINEER AND BUILDING/FIRE DEPARTMENTS FOR REVIEW PRIOR TO INSTALLATION.

EQUIPMENT CONNECTION NOTES:

- MECHANICAL EQUIPMENT DENOTED ON PLANS BY EQUIPMENT TAGS, REFER TO MECHANICAL EQUIPMENT SCHEDULES FOR ADDITIONAL INFORMATION. COORDINATE EXACT CONNECTION REQUIREMENTS, OUTLET CONFIGURATIONS, AND/OR CONDUIT ENTRY LOCATIONS OF MECHANICAL EQUIPMENT WITH INSTALLING CONTRACTOR. NO EXTRAS WILL BE ALLOWED FOR ADDITIONAL CIRCUITS AND ACCESSORY CONNECTIONS SHOWN ON APPROVED MECHANICAL SHOP DRAWINGS. REFER TO SPECIFICATIONS FOR COORDINATION DRAWING REQUIREMENTS.
- MAKE ALL FINAL ELECTRICAL TERMINATIONS TO EQUIPMENT REQUIRING POWER AND/OR CONTROL. THIS SHALL INCLUDE BUT NOT BE LIMITED TO ALL MECHANICAL OWNER, SPECIALTY, AND/OR FRSE INCLUDED IN THIS PROJECT. COORDINATE EXACT CONNECTION REQUIREMENTS, OUTLET CONFIGURATIONS, AND/OR CONDUIT ENTRY LOCATIONS OF EQUIPMENT WITH INSTALLING CONTRACTOR.
- PIPING AND/OR DUCTWORK SHALL NOT BE ROUTED IN THE DEDICATED ELECTRICAL EQUIPMENT SPACE OF ELECTRICAL SWITCHBOARDS, DISTRIBUTION BOARDS, PANELBOARDS, ETC. PROVIDE DEPTH AND WIDTH OF WORKING SPACE FOR ELECTRICAL EQUIPMENT AS REQUIRED BY NEC.
- BUILDING POWER HAS BEEN SHOWN ON DRAWINGS TO 1-BOXES FOR ANCILLARY POWER SUCH AS BAS/BSM CONTROLLER, DAMPER MOTORS, ETC. COORDINATE FINAL REQUIREMENTS WITH MECHANICAL CONTROLS CONTRACTOR AND INSTALLED EQUIPMENT. CIRCUITS SHALL BE DEDICATED TO THAT PURPOSE AND SHALL NOT CONTAIN ANY OTHER GENERAL LOADS.
- PROVIDE ADDITIONAL SUPPORT FOR SWITCHES, STARTERS, RACEWAYS, AND OTHER ELECTRICAL EQUIPMENT WHEREVER THE BUILDING STRUCTURE IS NOT SUITABLE FOR DIRECT MOUNTING.
- LOCATE ALL OUTLETS AND DISCONNECT SWITCHES WHERE ACCESSIBLE. PROVIDE WORKING CLEARANCE AS REQUIRED BY NEC. PROVIDE ACCESS HATCH WHERE LOCATED ABOVE HARD ID CEILING.
- YAW UNITS SHOWN WITH INTEGRAL 120V/24V TRANSFORMER. IF A CENTRAL POWER SUPPLY IS FURNISHED, PROVIDE CONNECTIONS TO EACH UNIT AS REQUIRED.

ONE LINE DIAGRAM NOTES:

- PANELBOARD AND BREAKER INTERRUPTING CAPACITIES (AIC) SHALL BE FULLY RATED AS AN ASSEMBLY. SERIES RATING OF BREAKER DEVICES AND EQUIPMENT IS NOT PERMITTED.
- ALL CONDUCTOR SIZES ARE BASED ON COPPER.
- WHERE SPECIFIED WIRE SIZE IS NOT A STOCKED ITEM AND INCURS COSTS ABOVE THE NEXT LARGER TRADE SIZE, IT SHALL BE ACCEPTABLE TO SUBSTITUTE WITH THE MORE COST-EFFECTIVE WIRE SIZE. CONDUIT SIZING AND GROUND CONDUCTOR SHALL BE ADJUSTED ACCORDINGLY AS A RESPONSIBILITY OF THE CONTRACTOR PRIOR TO ROUGH-IN OR ORDERING OF MATERIALS.
- VERIFY MECHANICAL EQUIPMENT AND CONTROLLERS ARE RATED FOR AVAILABLE SHORT CIRCUIT CURRENTS. PROVIDE FUSED DISCONNECT WITH CURRENT LIMITING RK1 TYPE FUSES AS REQUIRED.
- DO NOT SPlice FEEDER CONDUCTORS TO PANELBOARDS, SWITCHBOARDS, OR TO MOTORS UNLESS PRIOR APPROVAL HAS BEEN OBTAINED FROM THE ENGINEER.
- PROVIDE SEPARATE INSULATED GROUNDING CONDUCTOR IN ALL NEW FEEDER, HOMERUN AND BRANCH CIRCUITS. ANY EXISTING RACEWAYS BEING USED AS GROUNDING PATH, AND PART OF THE SCOPE OF THIS PROJECT, SHALL BE PROVIDED WITH NEW GROUND WIRE.
- PROVIDE ADJUSTABLE TRIP LSIG BREAKERS FOR ALL DISTRIBUTION BREAKERS EQUAL TO OR LARGER THAN 100A OR AS REQUIRED TO ALLOW FOR BREAKER COORDINATION AS PART OF THE REQUIRED COORDINATION STUDY PERFORMED BY THE CONTRACTOR.
- ONE-LINE DIAGRAMS ARE ONLY INTENDED TO DEPICT FEEDER CIRCUITS. BRANCH CIRCUITS ARE NOT GENERALLY CALLED OUT. REFER TO PANELBOARD SCHEDULE(S) FOR REQUIREMENTS. ALL 20A/1P BRANCH CIRCUITS SHALL BE WIRED WITH #12 AWG CONDUCTORS AT A MINIMUM UNLESS OTHERWISE NOTED.
- CONTRACTOR SHALL PREPARE THE SHORT CIRCUIT AND COORDINATION STUDY PRIOR TO ORDERING DISTRIBUTION EQUIPMENT TO VERIFY ALL EQUIPMENT RATINGS, BREAKER TYPES, AND SETTINGS REQUIRED. ANY CHANGES TO EQUIPMENT RATINGS OR BREAKER TYPES IN ORDER TO PROVIDE A FULLY COORDINATED SYSTEM SHALL NOT RESULT IN ADDITIONAL COST TO THE OWNER. POWER SYSTEM STUDIES SHALL BE SUBMITTED SIMULTANEOUSLY WITH SUBMITTALS FOR NEW EQUIPMENT OR THE EQUIPMENT SUBMITTALS WILL BE RETURNED AS REJECTED WITHOUT REVIEW.
- UPDATE PANEL SCHEDULE TO REFLECT CIRCUIT ARRANGEMENTS AFTER CONTRACTOR HAS BALANCED LOAD TO WITHIN 20% NEW CIRCUIT DIRECTORIES SHALL BE TYPEWRITTEN.
- NEW BREAKERS SHALL BE COMPATIBLE WITH AND LISTED FOR USE IN EXISTING EQUIPMENT.

ELECTRICAL ONE-LINE LEGEND

PLAN	DESCRIPTION
	CIRCUIT BREAKER
	DISCONNECT SWITCH
	UTILITY METER
	CURRENT TRANSFORMER
	GROUND
	CONTRACTOR
	COIL
	SERVICE WEATHERHEAD
	MOTOR
	DISCONNECT, SOLID NEUTRAL, FUSED
	DISCONNECT, SOLID NEUTRAL, NON-FUSED
	MOTOR STARTER / CONTACTOR
	FUSE
	ENCLOSED CIRCUIT BREAKER
	JUNCTION BOX
	AMP METER
	VOLT METER
	KIRK KEY INTERLOCK SYSTEM
	GROUND FAULT PROTECTION
	SHUNT TRIP
	FAULT CURRENT
	VARIABLE FREQUENCY DRIVE
	EMERGENCY POWER OFF
	SURGE SUPPRESSION DEVICE
	ELECTRICAL PANELBOARD
	AUTOMATIC TRANSFER SWITCH
	STEP DOWN TRANSFORMER (#B INDICATES KVA)
	K-RATED STEP DOWN TRANSFORMER (#B INDICATES KVA)
	SERVICE ENTRANCE TRANSFORMER
	GENERATOR
	GENERATOR REMOTE ANNUNCIATOR PANEL

CABLE / PATHWAY LEGEND

PLAN	DESCRIPTION
	CEILING SPACE / OVERHEAD WIRING
	UNDERGROUND / UNDER SLAB WIRING
	EXPOSED PATHWAY
	CONTROLS AND/OR SIGNAL WIRING
	SURFACE MOUNT PATHWAY (WIREMOLD)
	PATHWAY / CABLE TURNS UP, TURNS DOWN

POWER LEGEND

CLG	FLR	WALL	DESCRIPTION
			SINGLE RECEPTACLE
			DUPLEX RECEPTACLE
			GFI DUPLEX RECEPTACLE
			QUAD RECEPTACLE
			GFI QUAD RECEPTACLE
			SPECIAL RECEPTACLE (SUBSCRIPT DENOTES TYPE)
			JUNCTION BOX
			HALF SWITCHED RECEPTACLE
			ISOLATED GROUND RECEPTACLE
			SINGLE POLE SWITCH
			FUSED SWITCH
			MANUAL SWITCH, HORSEPOWER RATED
			SWITCH WITH PILOT LIGHT
			THERMAL OVERLOAD SWITCH
			PANELBOARD
			DISCONNECT
			GROUND BAR

PLAN CALLOUT:
DEVICE MOUNTED ABOVE COUNTER
DEVICE MOUNTED UNDER COUNTER
DEVICE MOUNTED AT SPECIFIC ELEVATION
HARDENED/WEATHERPROOF DEVICE & IN USE COVER
DUPLEX WITH TWO INTEGRAL USB PORTS

Legend:
AC = AC
UC = UC
48" = 48"
WP = WP
USB-C = USB-C

LIGHTING LEGEND

PLAN	DESCRIPTION
	SURFACE LIGHT FIXTURE
	RECESSED LIGHT FIXTURE
	RECESSED DOWNLIGHT - ROUND
	RECESSED DOWNLIGHT - SQUARE
	SURFACE FIXTURE - ROUND
	STRIP FIXTURE
	PENDANT FIXTURE - ROUND
	PENDANT FIXTURE - RECTANGULAR
	LINEAR WALL FIXTURE
	WALL SCONCE FIXTURE
	STEP LIGHT FIXTURE
	NIGHT LIGHT FIXTURE
	3' UNDERCABINET LIGHT
	EXTERIOR WALLPACK FIXTURE
	EXTERIOR BOLLARD FIXTURE
	EXTERIOR STREET/PARKING POLE FIXTURE
	EMERGENCY LIGHT
	EXIT SIGN w/ EMERGENCY LIGHT (FACES/ARROWS AS INDICATED)
	CEILING MOUNTED EXIT SIGN (FACES/ARROWS AS INDICATED)
	WALL MOUNTED EXIT SIGN (FACES/ARROWS AS INDICATED)
	SIDE MOUNTED EXIT SIGN (FACES/ARROWS AS INDICATED)
	SINGLE POLE SWITCH
	THREE-WAY SWITCH
	DIMMER SWITCH
	MOMENTARY CONTACT SWITCH
	MANUAL SWITCH, INTEGRATED PIR SENSOR
	SWITCH WITH INDICATOR LIGHT
	PHOTOCELL
	TIME CLOCK
	CEILING MOUNTED OCCUPANCY SENSOR
	WALL MOUNTED OCCUPANCY SENSOR
	LIGHTING CONTROL PANEL

EMERGENCY DESIGNATION:
FIXTURES WITH HATCH GRAPHIC INDICATES LIGHTS ON EM OKT

Legend:
ON = ON
OFF = OFF
EM OKT = EM OKT

ELECTRICAL ABBREVIATIONS

A	AMPERE
AC	ABOVE COUNTER
ADA	AMERICANS WITH DISABILITIES ACT
AFAT	AMP FRAME, AMP TRIP
AFB	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AIC	AMPERES INTERRUPTING CAPACITY (SYMMETRICAL)
ASAF	AMP SWITCH, AMP FUSE
ATS	AUTOMATIC TRANSFER SWITCH
AWG	AMERICAN WIRE GAUGE
BAS	BUILDING AUTOMATION SYSTEM
BFG	BELOW FINISHED GRADE
C	CONDUIT
CB	CIRCUIT BREAKER
OKT	CIRCUIT
CLG	CEILING
CT	CURRENT TRANSFORMER
DISC	DISCONNECT
(E)	EXISTING
EPO / ESD	EMERGENCY POWER OFF / EMERGENCY SHUT DOWN
FLA	FULL LOAD AMPS
FS	FIRE SMOKE DAMPER
GFI	GROUND FAULT CIRCUIT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GND	GROUND
HOA	HAND-OFF AUTO SELECTOR
HP	HORSEPOWER
IG	ISOLATED GROUND
KVA	KILOVOLT AMPERES
KW	KILOWATT
MCA	MINIMUM CIRCUIT AMPACITY
MCB	MAIN CIRCUIT BREAKER
MCM	THOUSAND CIRCULAR MILS
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MLO	MAIN LUGS ONLY
MOCP	MAXIMUM OVERCURRENT PROTECTION
NC / NO	NORMAL CLOSED / NORMALLY OPEN
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NF	NON-FUSED
NC	NOT IN CONTRACT
NL	NIGHT LIGHT (SECURITY)
NXS	NOT TO SCALE
NO	NO CONNECTION
OFDI	OWNER FURNISHED, CONTRACTOR INSTALLED
PROVIDE	FURNISH AND INSTALL
(R)	RELOCATED
SPD	SURGE PROTECTION DEVICE
TYP	TYPICAL
UC	UNDER COUNTER
UG	UNDERGROUND
UN	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SYSTEM
V	VOLTS
VA	VOLT AMPERES
VFD	VARIABLE FREQUENCY DRIVE
WP	WEATHERPROOF
XTMR	TRANSFORMER
%Z	PERCENTAGE IMPEDANCE

PLAN SYMBOLS LEGEND

PLAN	DESCRIPTION
	DRAWING KEYNOTE
	DEMOLITION DRAWING KEYNOTE
	REVISION CLOUD TAG
	MECHANICAL EQUIPMENT CALLOUT
	LIGHTING CONTROL
	TYPICAL CIRCUIT NUMBER
	TYPICAL LUMINAIRE TYPE
	MISC./OWNER EQUIPMENT CALLOUT
	MEDICAL EQUIPMENT CALLOUT
	DOOR NUMBER
	ELEVATION/SECTION CALLOUT



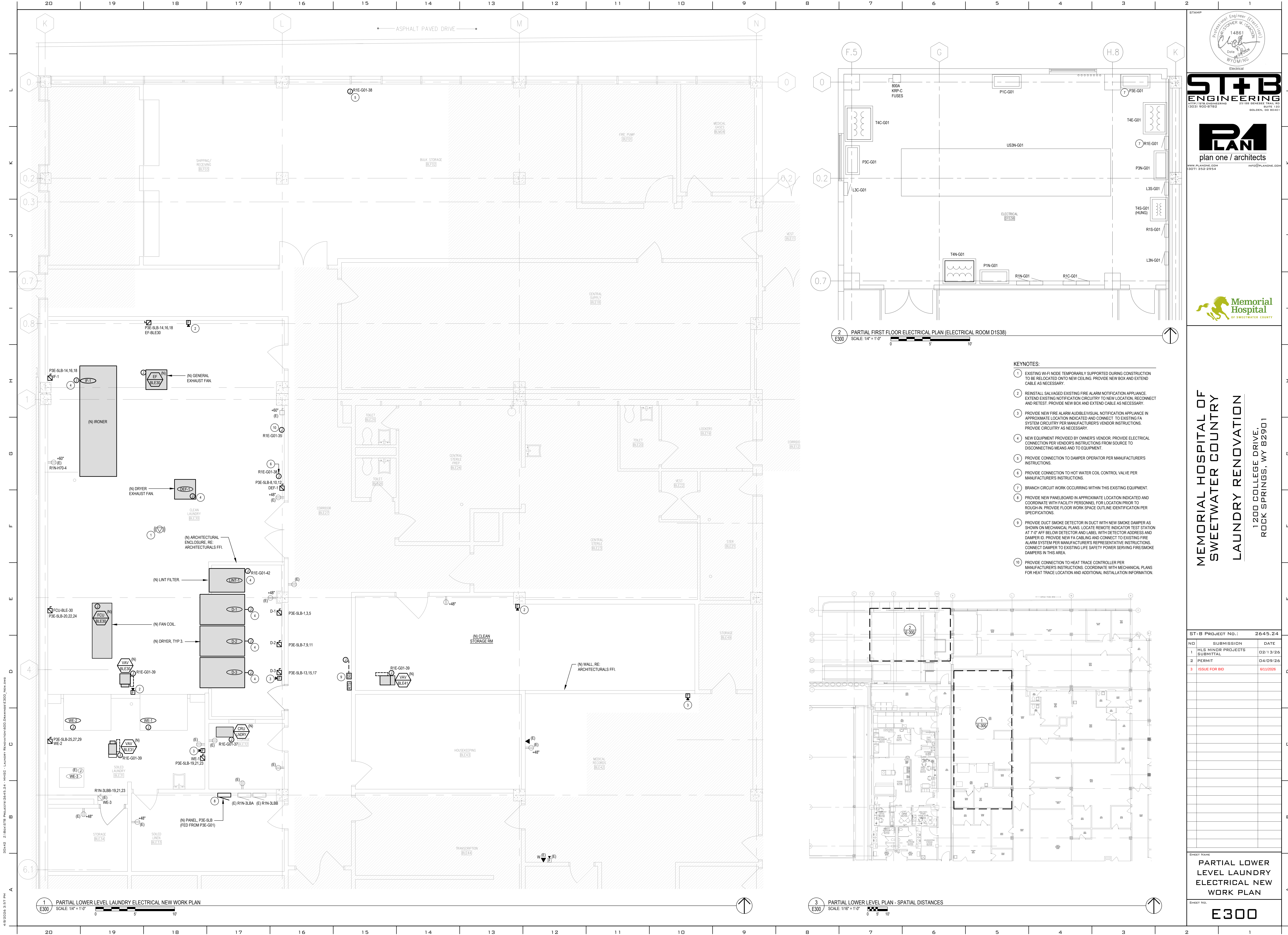
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- Memorial
Hospital**
OF SWEETWATER COUNTY

MEMORIAL HOSPITAL OF
SWEETWATER COUNTRY
LAUNDRY RENOVATION

1200 COLLEGE DRIVE,
ROCK SPRINGS, WY 82901

[illegible]

SHEET NAME	PARTIAL LOWER LEVEL LAUNDRY LIGHTING NEW WORK PLAN
SHEET NO.	E200



Professional Engineer (Electrical)
14861
Date: 04/09/26
WYOMING
Electrical

ST+B
ENGINEERING

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MEMORIAL HOSPITAL OF
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ST+B PROJECT NO.: 2645.24		
NO	SUBMISSION	DATE
1	HLS MINOR PROJECTS SUBMITTAL	02/13/26
2	PERMIT	04/09/26
3	ISSUE FOR BID	01/12/26

SHEET NAME

PARTIAL LOWER
LEVEL LAUNDRY
ELECTRICAL NEW
WORK PLAN

SHEET NO.

E300

VERSION 02.19.2025
GENERAL NOTES:

GENERAL NOTES:

GENERAL NOTES:

LOAD TYPES	CONNECTED LOAD (VA)	SUBFEED	PANEL	DEMAND LOAD (VA)

LOAD TYPES	CONNECTED LOAD (VA)	SUBFEED	PANEL	DEMAND LOAD (VA)

OVERALL LOAD SUMMARY

DETAILED LOAD SUMMARY

GENERAL NOTES:

GENERAL NOTES:

SHEET NAME

