University of California, Riverside

950464 - Batchelor Hall - Building Systems Renewal

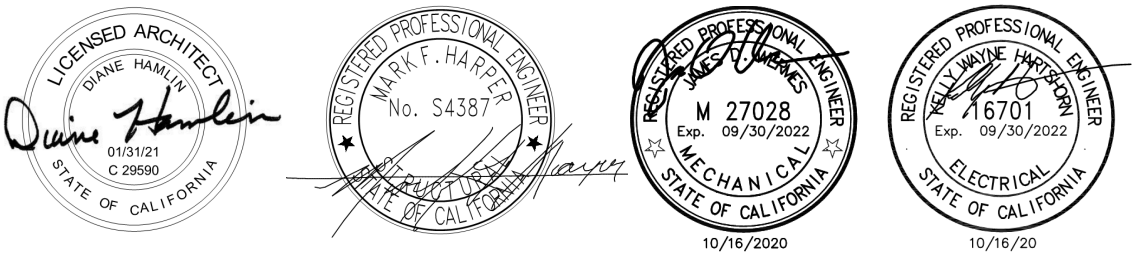
Construction Documents
Project Manual

100% Construction

10/16/20

Contract No. 950464-CMAR-2019-84

HDR Project No. 10044183



Building Permit B19-337

APPROVED
UC RIVERSIDE
Office of Planning, Design & Construction Signed C&O: Gilbert Granados
Building, Safety and Compliance Division
CAMPUS BUILDING PERMIT

Reviewed
01/28/21

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Work Covered by Contract Documents
2. Work Sequence – Not Used
3. Work by University
4. University Furnished Products – Not Used

B. In case any Sections contain conflicting requirements, refer to General Conditions, Paragraph 4.1.8.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The University of California, Riverside (UCR) intends to procure the services of a General Contractor (Contractor) to upgrade the existing infrastructure to provide new efficient and code compliant mechanical, electrical, fire protection, exhaust and plumbing systems.

B. Work consists of, but not limited to the following: demolition of existing improvements, addition/alterations of walls, alterations/additions to the mechanical, electrical, plumbing, fire life safety and fire suppression, and telecommunication systems.

C. The Contract Time to complete the Work of this Contract is specified in the Supplemental Instructions to Bidders.

D. Project Location: Batchelor Hall.

1.3 WORK SEQUENCE – NOT USED

1.4 WORK BY UNIVERSITY

A. Connects, disconnects, and all shut downs by the Contractor of MEP and other building systems shall be coordinated through the University's IOR, Facilities Services and SOM.

B. Batchelor Hall will be occupied in adjacent spaces by faculty, staff, students, and possibly visitors. Contractor shall coordinate all work activity to eliminate and minimize all disruptions to the occupied areas. Communication on a daily basis between all parties will be required.

1.5 UNIVERSITY FURNISHED PRODUCTS – NOT USED

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 14 00
WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Access to Site
2. Coordination with Occupants
3. Use of Site
4. Scheduling of Work and Work Hours
5. Neighbor Complaint Hotline – Not Used
6. Site Decorum

1.2 ACCESS TO SITE

A. Special Requirements
1. Existing Site Conditions and Restrictions:
   a. Maintain access and code required exiting to and from surrounding buildings during construction.
2. Contractor shall be responsible for safely securing the work areas, with at a minimum, trench plates, fencing, signage, safety lighting, traffic and pedestrian coordinators.
3. Trench plates shall be provided and safely secured at all roadway, parking lots, and walkways.
4. Trenches shall be protected from vehicles by utilizing trench plates, and from pedestrians by utilizing fully installed galvanized fencing. Excavations and holes shall be protected by utilizing fully installed galvanized fencing, safety lighting, and other methods to safely secure the site. Establishment of the work area in any space requiring the University's vacating shall not commence before notification to University's Representative. Refer to Section 01 14 00 - CONTRACTOR'S USE OF THE PROJECT SITE, Notifications.
5. Individual work areas shall not be established until Contractor has labor, materials and equipment ready to commence and complete the Work in that area.
6. Work shall not commence in any area until barriers and other protections are in place.

B. Use of Public Thoroughfares and University Roads
1. Contractor shall make its own investigation of the condition of available public thoroughfares and University roads, and of the clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the Project site.
2. Where materials are transported in the prosecution of the Work, do not load vehicles beyond the capacity recommended by manufacturer of the vehicles or prescribed by any applicable state or local law or regulation.
3. Use only established roads on the campus; provided, however, that such temporary haul roads as may be required in the work shall be constructed and maintained by Contractor, subject to the approval of University's Representative. Refer to Section 01 35 43 Environmental Mitigation for description of the approved haul route to and from the campus.
4. Provide protection against damage whenever it is necessary to cross existing sidewalks, curbs, and gutters in entering upon the University roads and public thoroughfares. Repair and make good immediately at the expense of Contractor all damages thereto, including damage to existing utilities and paving, arising from the operations under the Contract.
5. Truck staging is not allowed on campus or on any residential street surrounding the campus.

C. See also Section 01 55 00, Vehicular Access and Parking.

1.3 COORDINATION WITH OCCUPANTS

A. The University reserves the right to occupy and to place and install equipment in completed areas of the Work prior to Notice of Completion, provided such occupancy does not interfere with completion of the Work and subject to the General Conditions. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
   1. Partial occupancy of the Work may occur upon University's approval, in which case the University's Representative will prepare a Certificate of Beneficial Occupancy for each specific portion of the Work to be occupied prior to Final Completion of the entire Work.
   2. Refer to Article 9.6 of the General Conditions.

1.4 USE OF SITE

A. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
   1. Driveways and Entrances: Keep driveways and entrances serving adjacent buildings clear and available to the University, and its employees, students, faculty, visitors, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for use of these areas.
   2. Contractor's use of the Project site for the work, staging, deliveries, and storage is restricted to the project limits on the Drawings, or as directed by the University's Representative.
   3. All material for construction operations shall be brought in and the work conducted so as to avoid any interference with existing University facilities or their normal operations.
   4. Noise from job equipment shall be kept to a minimum by use of adequate mufflers and other appropriate means.
   5. Delivery of Materials: Arrange for delivery of materials and equipment to minimize length of on-site storage prior to installation. Delivery route shall be from South Campus Circle Drive to Big Springs Road to the project site, or as designated by the University's Representative.
   6. The Contractor shall take appropriate steps throughout the term of the project to prevent airborne dust due to work under this contract. Water shall be applied wherever practical to settle and hold dust to a minimum, particularly during excavation and moving of materials. No chemical palliatives shall be used.

1.5 SCHEDULING OF WORK AND WORK HOURS

A. Normal **Interior** Construction Hours: All Contractors shall ensure that all construction activities will occur between 6:00 a.m. and 4:00 p.m. Monday through Saturday, or as approved by the University Representative. University Representative shall approve all construction shifts. Overtime hours for construction shall require University Representative's approval. The University will not allow for work to be performed on days as designated as University Holidays without the University's Representative's approval. Work outside of regular work hours required to accomplish work of this contract shall be included in the contract sum.

B. Restrict Construction Hours: All contractors, and overseen by the General Contractor, shall ensure that all construction contracts will limit **EXTERIOR** construction activities to occurring between 6:00 a.m. and 4:00 p.m. Monday through Friday, and 8 a.m. and 5 p.m. on Saturday, unless otherwise approved by the University's Representative. Construction will not be allowed on Sunday or federal holidays.

C. Overtime work requests must be submitted to the University's Representative three working days before the work is to commence.
   1. Additional overtime operating hours may be approved at the University's Representative sole discretion and only without change to the contract sum.
   2. Contractor shall pay all the inspectors (in-house inspectors and University's testing laboratory inspectors) and University's Representative's costs if the overtime request is approved by University's Representative.

1.6 NEIGHBOR COMPLAINT HOTLINE – NOT USED

1.7 SITE DECORUM

A. Contractor shall control the conduct of its employees (including subcontractor's employees) so as to prevent unwanted interaction initiated by Contractor's employees with University of California Riverside (UCR) students, UCR staff, UCR Faculty or other individuals (except those associated with the Project), adjacent to the Project site. Without limitation, unwanted interaction by Contractor employees would include whistling at or initiating conversations with passersby. In the event that any Contractor employee initiates such unwanted interaction, or utilized profanity, Contractor shall, either upon request of University's Representative or on its own initiative, replace said employee with another of equivalent technical skill, at no additional cost to the University. No radios, other than two-way communication type, will be allowed on the Project site. No smoking is allowed in any University Building.

B. Contractor shall control the conduct of its employees (including subcontractor's employees) to prevent unwanted interaction initiated by Contractor's employees with UCR students, staff, Faculty or other individuals, adjacent to the Project site. Unwanted interaction by Contractor employees includes whistling at, or initiating conversations with, passersby. If any contractor employee initiates such unwanted interaction, or utilizes profanity, Contractor shall, upon request of University's Representative or on its own initiative, replace said employee with another of equivalent technical skill, at no additional cost to University. No radios, other than two-way communication type, will be allowed on the Project site. No smoking is allowed in any existing University Building or University Building under Construction.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 23 00
ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Procedures
   2. Alternate Descriptions

B. This Section identifies each Alternate and describes basic changes to the Work only when that Alternate is made a part of the Work by specific provision in the Agreement.

C. Definition: Refer to the Instructions to Bidders, 1.2 for the term "Alternate."

1.2 PROCEDURES

A. The Lump Sum Base Bid and Alternates shall include the costs of all supporting elements required, so that the combination of the Lump Sum Base Bid and any Alternates shall be complete. The scope of Work for all Alternates shall be in accordance with applicable Drawings and Specifications.

B. Except as otherwise specifically provided by University, the Work described in Alternates shall be completed with no increase in Contract Time.

C. This Section includes only the non-technical descriptions of the Alternates. Refer to the specific Sections of Divisions 02-28 of the Specifications for technical descriptions of the Alternates.

D. Coordinate related Work and modify surrounding Work as required to properly and completely integrate the Alternates into the Work.

1.3 ALTERNATE DESCRIPTIONS

A. Alternate No. 1: Not Used

B. Alternate No. 2: Not Used

C. Additive Alternate No. 3: Elevator Modernization.
   1. Provide elevator modernization for elevator #1, as specified in 14 22 10

      No extension of the Contract Time will be granted if this Alternate is accepted.

      University reserves the right to accept this Alternate within 200 calendar days after the commencement date per the Notice to Proceed.

D. Additive Alternate No. 4a and 4b: Card Readers at Exterior Doors.
   1. Provide required modifications to add card readers at doors noted on the DOOR AND FRAME SCHEDULE - ALTERNATE #4 on sheet A-601, Architectural Floor Plans (A-100 Series), Electrical Telecom/Security Plans (ET Series drawings) and hardware groups described within 08 71 00.
      4a) Provide base alternate scope for Level 1 and Level 2 doors (9) doors total
      4b) Provide unit pricing for individual doors on levels 3 and 4 (6) doors total to be added as determined and selected individually by the University.

      No extension of the Contract Time will be granted if this Alternate is accepted.

      University reserves the right to accept this Alternate within 200 calendar days after the commencement date per the Notice to Proceed.

E. Additive Alternate No. 5: Fire Sprinkler Scope.

1. Provide as shown on the Fire Protection drawing(s) F-10x-ALT series, and in accordance with specification section 21 10 00.
2. Provide the new fire protection entrance, and the new stair combination riser standpipes.
3. Provide the fire sprinkler area coverage distribution required for wet sprinklering all the occupied spaces.
4. The alternate includes removal of the corridor ceilings as shown on the AD-11x series drawings and lighting as shown on the EL-10x-A5 drawings. Corridors to be painted as required where existing ceilings are removed per AC-10x series drawings to match adjacent surface with paint extending to underside of concrete structure.

No extension of the Contract Time will be granted if this Alternate is accepted.

University reserves the right to accept this Alternate within 200 calendar days after the commencement date per the Notice to Proceed.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 26 13

REQUESTS FOR INFORMATION & INSTRUCTIONS (RFI) PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section contains the procedures to be followed by Contractor upon discovery of any apparent conflicts, omissions, or errors in the Contract Documents or upon having any question concerning interpretation.

1.2 PROCEDURES

A. Notification by Contractor:
   1. Submit all requests for clarification or additional information in writing to Design Professional and University's Representative concurrently using the **Request for Information (RFI) form attached to this Section**.
      a. All RFI's, and any attachments thereto, must be submitted in PDF format with Optical Character Recognition (OCR) Text.
      b. When submitting RFIs the Contractor shall include in the email Subject Line the following information:

         Project Number, Project Name, and RFI Number:
         Example: 958091 SOM CSSS – RFI #1

         The Contractor will forward the email to the following:

         Design Professional
         University's Representative
         Project Specialist
         Inspector of Record
         And others as requested by the University's Representative.

   2. Limit each RFI to one subject and number RFI's sequentially. For each resubmission, follow the RFI number with suffix "R" sequentially numbered as necessary. For example, the first RFI would be "1." The second RFI would be "2." The first resubmittal of RFI "2" would be "2R1."
   3. Submit a RFI if one of the following conditions occurs:
      a. Contractor discovers an unforeseen condition or circumstance that is not described in the Contract Documents.
      b. Contractor discovers an apparent conflict or discrepancy between portions of the Contract Documents that appears to be inconsistent or is not reasonably inferred from the intent of the Contract Documents.
      c. Contractor discovers what appears to be an omission from the Contract Documents that cannot be reasonably inferred from the intent of the Contract Documents.
   4. Contractor shall not submit a RFI:
      a. As a request for substitution.
      b. As a submittal.
      c. Under the pretense of a Contract Documents discrepancy or omission without thorough review of the Contract Documents.
      d. In a manner that suggests that specific portions of the Contract Documents are assumed to be excluded or by taking an isolated portion of the Contract Documents in part rather than whole.
      e. In an untimely manner without proper coordination and scheduling of Work of related trades.
      f. As a request for approval of Contractor's means and methods.

5. If Contractor submits a RFI contrary to 1.2. A.4. above, Contractor shall pay the cost of any review, which cost shall be deducted from the Contract Sum.
6. Contractor shall submit a RFI immediately upon discovery. Contractor shall submit RFI's within a reasonable time frame so as not to delay the Contract Schedule while allowing the full response time described below.

B. Response Time:
1. Design Professional shall send its RFI response to University's Representative within a reasonable time so that University's Representative can send a final RFI response to Contractor within the time frames in 1.2. B.2. below.
2. University's Representative, or his/her designee, whose decision will be final and conclusive, shall resolve such questions and issue instructions or issue approval of instructions or information from Design Professional, to Contractor within a reasonable time frame. In most cases, RFI's will receive a response within **7 days for architectural issues and within 14 days for issues that require review and response from Design Professional's consultants.** In some cases, the response time may be lengthened for complex issues or shortened for emergencies as approved by University's Representative in writing. If in the opinion of University's Representative more than **14 days** is required to prepare a response to a RFI, Contractor will be notified in writing.
3. Should Contractor proceed with the Work affected before receipt of a response from University's Representative within the response time described above, any portion of the Work which is not done in accordance with University's Representative's interpretations, clarifications, instructions, or decisions is subject to removal or replacement and Contractor shall be responsible for all resultant losses.
4. Failure to Agree: In the event of failure to agree as to the scope of the Contract requirements, Contractor shall follow procedures set forth in Article 4 of the General Conditions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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REQUEST FOR INFORMATION

DATE: mm/dd/yy **RFI #:** _____

TO: **FROM:**

Cc:

Subject/Title:

☐ Electrical

☐Architectural ☐ Civil ☐ Mechanical ☐ Plumbing ☐ Structural ☐Fire Protection ☐ Landscape ☐ Other: _____

Reason(s) for RFI:

☐ Clarification/Interpretation
☐ Coordination Issue
☐ Cost Impact: _____
☐ Conflict in CD's
☐ Information Not Shown on CD's
☐ Safety
☐ Work/Time Impact: _____

Issue/Question:
(Reference Attachments)

Specification #: _____ Paragraph #: _____ Sheet #: _____ Detail #: _____
Other Reference: _____ Schedule Activity: _____

Proposed Solution:
(Reference Attachments)

Signed by Contractor: _____ **Response Required by Date:** mm/dd/yy

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RESPONSE TO CONTRACTOR:

From Design Professional:
(Reference Attachments)

Date Received RFI: mm/dd/yy **Response Date:** mm/dd/yy **Signed:** _____

From University's Rep.:
(Reference Attachments)

Date Received RFI: mm/dd/yy **Response Date:** mm/dd/yy **Signed:** _____

APPROVED
UC RIVERSIDE
Office of Planning, Design & Construction Signed CAO: Gilbert Granados
Building, Safety and Compliance Division
CAMPUS BUILDING PERMIT

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SECTION 01 31 13
COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:
   1. Administrative Requirements
   2. Facilities Services Coordination and Service Continuity

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordinate construction operations including, but not limited to, the following:
   1. Coordinate the Work and do not delegate responsibility for coordination to any Subcontractor.
   2. Anticipate the interrelationship of all Subcontractors and their relationship with the Work.
   3. Resolve differences or disputes between Subcontractors and their relationship with the Work.
   4. Coordinate the Work of Subcontractors so that portions of the Work are performed in a manner that minimizes interference with the progress of the Work.
   5. Do not obstruct spaces and installations that are required to be clear by Applicable Code Requirements.
   6. Do not cover any piping, wiring, ducts, or other installations until they have been inspected and approved and required certificates of inspection issued.
   7. Remove and replace all Work, which does not comply with the Contract Documents. Repair or replace any other Work or property damaged by these operations with no adjustment of Contract Sum.

B. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation. Coordinate all portions of the Work requiring careful coordination in order to fit in space available. Before commencing such portions of the Work, prepare supplementary Drawings for review by University's Representative and Design Professional. Non-conformance of this task will result in the delay of applications for payment and the contractor responsibility for any remedial works requested by University Representative.
   1. Schedule construction operations in the 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 assure maximum accessibility for required maintenance, service, and repair.
   3. Make provisions to accommodate items scheduled for later installation, including, but not limited to, coordination of furnishing and placing embedded items, sleeves, and block-outs with formwork and reinforcing steel for cast-in-place concrete.
   4. Resolve conflicts and coordinate access to, and utilization of, spaces available for construction activities on the site and within structures, and delivery, storage, and installation of materials and equipment.
   5. Implement a quality assurance program designed to ensure completion of the Work in accordance with requirements of the Contract Documents.

C. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the University and separate contractors where coordination of their work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of schedules.
   2. Installation and removal of temporary facilities.
   3. Delivery and processing of submittals.
   4. Progress meetings.
   5. Project closeout activities.
   6. Obtaining required permits and approvals from authorities having jurisdiction.
   7. Utility company approvals and installations.

E. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

F. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.

G. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

1.3 FACILITIES SERVICES COORDINATION AND SERVICE CONTINUITY

A. Maintain continuous services to all existing facilities during the period of construction except for the following conditions:
   1. Perform Work that involves "shut-down" of existing facilities at such times as will cause the least inconvenience to the University activities, performing at night, on Saturdays, Sundays, holidays and at the discretion of University's Representative. Furnish University's Representative written notice of exact date and time of "shut-down" at least **thirty (30) working days** in advance, unless a longer period is specified or shown on the Drawings. On jobs with short performance time, Contractor shall verify with University's Representative the number of days required in advance for shut-down.
   2. The University's preference would be for the contractor to try to coordinate the high voltage utility shut down simultaneously with the Student Recreation Center's shut down to avoid unnecessary inconvenience to the campus. However this preference is not a mandatory requirement if it doesn't fit in with the contractor's schedule.
   3. The Contractor's bid shall include the cost of overtime necessary for the Work. No extra payment will be allowed for overtime to meet this requirement or the Contract Schedule.

B. Service Continuity:
   1. Within the areas of the Work, investigate and uncover all drainage lines, sewers, electrical ducts, and other piping in use or forming continuations or utility systems required for other buildings or improvements upon the campus, and maintain such services in operation during performance of the Work of the Contract.

C. Notify University's Representative at least 30 days in advance of all utility shutdowns including date, time and expected duration.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for the following project meetings:
   1. Preconstruction Meeting
   2. Pre-Installation Meetings
   3. Progress Meetings
   4. Billing Meetings
   5. 11-Month Warranty Meeting

1.2 PRECONSTRUCTION MEETING

A. The University's Representative will schedule a preconstruction conference before starting construction, at a time convenient to the University and the University's Representative, but no later than 10 days after execution of the Agreement. The conference will be held at the Project Site or another convenient location. The meeting will review responsibilities and personnel assignments.
   1. Distribute written notice of agenda, meeting time, and location a minimum of five calendar days in advance.

B. Attendees: The University's Representative and authorized representatives of the Architect, and its consultants; the Contractor and its superintendent; major subcontractors; manufacturers; suppliers; Contractor's designated safety manager; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Items of significance that could affect progress, including the following:
   1. Tentative construction schedule.
   2. Critical work sequencing.
   3. Designation of responsible personnel.
   4. Procedures for processing field decisions and Change Orders.
   5. Procedures for processing Applications for Payment.
   6. Distribution of Contract Documents.
   7. Submittal of Shop Drawings, Product Data, and Samples.
   8. Preparation of record documents.
   9. Use of the premises.
   10. Parking availability.
   11. Office, work, and storage areas.
   12. Equipment deliveries and priorities.
   13. Safety procedures, including emergency notification procedures.
   14. First Aid.
   15. Security.
   16. Housekeeping.
   17. Working hours.
   18. Sustainability requirements, including Contractor staffing.

1.3 PRE-INSTALLATION MEETINGS

A. The Contractor shall conduct a pre-installation conference at the Project Site before each construction activity that requires coordination with other construction, and as required by other sections of the specifications.

1. The Contractor shall distribute written notice of agenda, meeting time, and location a minimum of five calendar days in advance.

B. Attendees: The Installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the University's Representative of scheduled meeting dates.
   1. Review the progress of other construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for the following:
      a. Contract Documents
      b. Options
      c. Related Change Orders
      d. Purchases
      e. Deliveries
      f. Shop Drawings, Product Data, and quality-control samples
      g. Possible conflicts
      h. Compatibility problems
      i. Time schedules
      j. Weather limitations.
      k. Manufacturer's recommendations
      l. Warranty requirements
      m. Compatibility of materials
      n. Acceptability of substrates
      o. Temporary facilities
      p. Space and access limitations
      q. Governing regulations
      r. Safety
      s. Inspecting and testing requirements
      t. Required performance results
      u. Recording requirements
      v. Protection.
   2. Record significant discussions and agreements and disagreements of each conference, and the approved schedule. Promptly distribute the record of the meeting to everyone concerned, including the University and the University's Representative.
   3. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.4 PROGRESS MEETINGS

A. The Contractor shall conduct progress meetings at the Project Site at regular intervals. Notify the University's Representative and the Design Professional of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment request. Document meetings with meeting minutes to be distributed to the University's Representative, the Design Professional and all other attendees.

B. Attendees: In addition to representatives of the University and the Architect, each subcontractor, supplier, or 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 conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.
2. Review the present and future needs of each entity present, including the following:
   a. Interface requirements
   b. Time
   c. Sequences
   d. Status of submittals
   e. Status of RFIs
   f. Deliveries
   g. Off-site fabrication problems
   h. Access
   i. Site utilization
   j. Temporary facilities and services
   k. Hours of work
   l. Contractor's Safety Program (including any special hazards and risks)
   m. Housekeeping
   n. Quality and work standards
   o. Contractor's two week "look ahead" schedule and issues
   p. Change Orders
   q. Documentation of information for payment requests
   r. Sustainability review, including tracking and status.

D. Schedule Updating: Revise the Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

1.5 BILLING MEETINGS

A. Attend a meeting monthly 5 days prior to submittal of the Application for Payment, at a location acceptable to University's Representative.

B. Attendees:
   1. University's Representative.
   2. Design Professional and Consultants, as appropriate.
   3. Contractor's Project Manager.
   4. Superintendent.
   5. Others as directed by University's Representative.

C. Agenda:
   1. Determination of current schedule progress.
   2. Review of work completed based on the cost loaded schedule to be billed in the Application for Payment.

D. Schedule Updating: Revise the Contract Schedule prior to the meeting based on information determined at prior progress meetings. Review schedule revisions and prepare a final revised schedule for submission 10 days prior to the application for payment.

1.6 11-MONTH WARRANTY MEETING

A. Attend a meeting eleven months following the date of Notice of Completion.

B. Attendees:
   1. University's Representative
   2. Design Professional and Consultants, as appropriate
   3. Contractor's Project Manager

4. Subcontractors, as appropriate
5. Others as directed by Responsible Administrator.

C. Agenda: Review of guarantees, bonds, service and maintenance contracts for materials and equipment.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 32 00
DOCUMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the requirements for Contractor provided electronic document control system(s):
   1. General Requirements
   2. Submittals
   3. Software
   4. System Maintenance

1.2 GENERAL REQUIREMENTS

A. Contractor shall provide a web accessible system for electronic document control designed for use during pre-construction and construction to manage documents including RFIs and submittals.

B. Contractor shall provide an electronic document control system(s) that is accessible via a web browser (including IE version 7.7) from any geographical location.

C. Contractor shall provide access to University's Representative, University's Inspector of Record, Design Professional, and at least 7 other individuals identified by University's Representative.

D. The electronic document control system must use the University numbering system specified in the applicable Specification Section.

E. Hours of Operation: The electronic document control system shall be available 24 hours a day, 7 days a week except for short periods of planned system maintenance.

1.3 SUBMITTALS

A. Contractor shall submit a narrative description and outline of the proposed electronic document control system for review and approval by University's Representative.

B. Contractor shall submit an example of the electronic log for both RFIs and Submittals for review and approval by University's Representative.

C. Contractor shall establish a commercially available web based RFI and submittal processing system capable of posting RFI's and submittals with the following capabilities:
   1. Password secured access with varying levels of "write" or action capability, with multiple user defined stamps for action taken.
   2. Accessible from any computer with Internet access, whether in the office or the field.
   3. Notification of submittal status based on user profile.
   4. Automatic Transmittal generation when submittal is released.
   5. Extensive and user friendly mark-up tools and capability.
   6. Ability to hide mark-up comments based on user profile.
   7. Status of submittal and responsible party.
   8. Download in PDF format based on user profile.
   9. Tracking of resubmittal process, including University designated numbering system.

PART 2 - PRODUCTS

2.1 SOFTWARE

A. Primavera, Prolog or equal is acceptable as the electronic document control system used for RFIs and submittals.

2.2 SYSTEM MAINTENANCE

A. University shall be notified at least 48 hours in advance of planned system maintenance of the electronic document control system(s). Planned system maintenance should be scheduled not to interfere with construction activities whenever possible. The system uptime shall be at least 95% based on a rolling monthly average.

B. Contractor is responsible for installation, maintenance, and backup activities of the electronic document control system(s).

PART 3 - EXECUTION

3.1 UPDATES

A. Every two (2) weeks, Contractor shall export or otherwise generate electronic logs of all RFIs and submittals that can be imported into the University's enterprise system. The format of the electronic logs shall be a spreadsheet in MS-Excel format of all the structured data from each RFI or submittals. The exported or otherwise generated log for RFIs shall be separate from the log for submittals. Samples shall be included in the log of submittals.

B. Contractor shall also allow, at any time, the University's Representative or designee, to download electronic copies of such RFI and submittal documents in a format that is searchable such as printed PDFs. Scanned PDFs are not acceptable except in the case of drawings.

C. At least 7 days before the date scheduled for Final Inspection, Contractor shall provide University's Representative a complete electronic copy of all electronic files from the electronic document control system for the project.
   1. The electronic files shall be executable on CD or DVD.
   2. Each disc shall be fully labeled with the project name, contract number, date, and the sequence number of the disc in the set. Files may be submitted compressed, but the decompression utility used (executable preferred) should be fully described with directions included on the transmittal as well as in digital form.

END OF SECTION

SECTION 01325
SCHEDULES

PART 1 - GENERAL

1.1 DEFINITIONS

A. Preliminary Contract Schedule:
1. The schedule submitted and developed by CM/Contractor's prior to bidding any Bid Packages during Phase 1 which represents all Work for the Project. It is intended that the Preliminary Contract Schedule once received, reviewed and approved by University, would become the Contract Schedule. The Preliminary Contract Schedule shall reflect the requirements and information provided in the Project Schedule Exhibit.

B. Contract Schedule:
1. The schedule submitted by CM/Contractor representing the sole work plan for accomplishing the Work. Once the submitted Preliminary Contract Schedule is reviewed and accepted by University, it shall be the base line schedule document that forms the basis of all measurements of Contract Time in the Contract Documents. The Contract Schedule may not be modified other than as called for in this Section. The Contract Schedule shall be incorporated with all Bid Packages.

C. Updated Contract Schedule:
1. A periodically submitted schedule reflecting the progress of the Work for all Work Activities including 1) the portion of the Work Activities comprising the As-Built Schedule and 2) that portion of the Work Activities which are incomplete or not yet commenced.

D. Recovery Schedule:
1. If requested by the University, a schedule produced by the CM/Contractor upon receipt by University of an updated Contract Schedule forecasting the CM/Contractor will not finish the Work within the tolerances of the Contract Time.

E. As-Built Schedule:
1. The portion of the updated Contract Schedule maintained by the CM/Contractor that records the actual work activities, their durations, and their dependencies to all other work activities.

F. Float/Negative Float:
1. Float for any Work Activity, will be calculated as the difference in Days between the Latest Finish and its Earliest Finish. Any such calculated float, which results in a "negative" number, is considered Negative Float.

G. Constrained Work Activity:
1. Shall be any earliest start or finish; or latest start or finish date of a Work Activity or Milestone date that is set and is not calculated in the CPM forward or backward pass calculation. No work activities or milestones on the Contract Schedule, or any other submitted schedule shall utilize Constrained Work Activities, unless expressly approved in writing by University. The only exception is that the schedule start date may be set to reflect the Phase 1 Notice to Proceed date.

H. Work Activity:
1. Any individual task of work shown on a submitted schedule which requires time and resources (manpower, equipment, materials, etc.) to be completed in a continuous operation.

I. Milestone:
1. An element on the schedule that reflects the planned point in time for the start or finish of one or more Work Activities.

J. Look Ahead Schedule:
   1. A schedule based on the updated Contract Schedule which shows the current portion of the schedule. The current portion of the schedule is typically 3 weeks both before and beyond the date the schedule is presented, or as reasonably requested by the University's Representative.

K. Change Order Schedule:
   1. A schedule submitted anytime there is a request by the CM/Contractor for the adjustment in the Contract Time. Change Order Schedule shall be based on the applicable portion of the Contract Schedule, which is claimed to be impacted, necessitating an extension of the Contract Time. All modifications to the Contract Schedule Work Activities, and their associated information (including duration, logic, manpower, etc) shall be clearly identified, but the Contract Schedule information shall be left for clear comparison. Change Order Schedule shall have starting and ending Work Activities or Milestones from the Contract Schedule which are unchanged, (same logic constraints, duration, and resources) and shall clearly identify them.

L. Critical Work Activity:
   1. Work Activity which, if delayed, will delay the scheduled completion of the Work (i.e. Work Activities which comprise the path of least total float). All other Work Activities are defined as non-critical and considered to have float.

M. Contract Time:
   1. For the purposes of this specification only, it will be understood that Contract Time represents both the Contract Time allowed for Phase 1 as may be modified by Change Order, and the Option Time allowed for Phase 2 as may be modified by Change Order. If the University exercises its Option, Contract Time will have the same meaning as defined in the Agreement.

1.2 REQUIREMENTS

A. General Requirements:
   1. The CM/Contractor's personnel which prepares the schedules called for by this Section shall be qualified and experienced in Critical Path Method (CPM) scheduling with the specified products of this Section; and capable of fulfilling the requirements of this Section. The CM/Contractor shall hire a qualified consultant to prepare and maintain the Contract Schedule, or if qualified, the CM/Contractor may perform these services with his own organization. CM/Contractor shall provide documentation of scheduling experience for the University's Representatives approval.
   2. The Contract Schedule shall be used by the University in review of request by the CM/Contractor for modification of the Contract Time in accordance with the Contract Documents. Responsibility for developing the Contract Schedule and monitoring of actual progress in relation to the Contract Time rest solely with the CM/Contractor. Failure of the CM/Contractor to schedule any element of the Work, or any inaccuracy in the Contract Schedule, regardless if the University has reviewed and approved such schedule, will not relieve CM/Contractor from its obligation to complete the Work within the Contract Time. The CM/Contractor warrants that the Contract Schedule is the CM/Contractor's committed work plan to complete the Work within the Contract Time, and that the CM/Contractor assumes full responsibility for the execution of the Work. The University's review of and response to schedule submissions shall not be construed as relieving the CM/Contractor of its complete and exclusive control over the means, methods, sequences and techniques for execution of the Work.
   3. Any submitted schedule showing negative float will be rejected by the University.
   4. All cost for preparing, printing, mailing of any schedules called for by this Section, or the Contract Documents shall be part of the Contract Sum.
   5. All requirements of the Contract Schedule shall also apply to the Preliminary Contract Schedule, the Recovery Schedule, updated Contract Schedule, and Fragnet Schedule.

6. Acceptance of the Contract Schedule will be a condition precedent to making any progress payment for Work performed. All Work Activities shall be of sufficient detail to provide identification of all components utilized in executing, monitoring and evaluating progress of the Work.
7. Work Activity descriptions shall briefly cover the scope of work indicated. Work Activities shall be discrete items of Work that must be accomplished under the Contract and constitute definable, recognizable entities within the Project. All Work Activities shall have defined duration. All durations shall be in multiples of working days.
8. All Work Activities shall have appropriate durations allowing measurement of their progress. In general, if a reasonable estimate of progress against a proposed Work Activity cannot be reasonably measured, a Work Activity shall be broken into multiple Work Activities such that monitoring of actual progress versus planned progress can be ascertained. All Work Activities shall be of sufficient detail to provide identification of all components utilized in executing, monitoring and evaluating progress of the Work.
9. Work Activities shall have duration of 14 working days or less. University's Representative may approve use of longer Work Activity durations on non-construction activities, including the procurement and fabrication of materials and equipment, and review period for submittals.
10. Work Activities shall include all Design Work, Phase 1 and Construction Work deliverables, including all submittals called for in the Scope of Work; and shall include the submittal and approval of permit applications (as necessary), samples of materials, shop drawings, working drawings, testing and inspections, safety and security plans, worksite control plans, utility company point-of connection installations and applications. In addition, Work Activities shall be included for procurement of materials and equipment potentially impacting the critical path, fabrication of special materials and equipment and their installation and testing, and delivery of University-furnished items. Work Activities of the University, that may become Critical Work Activities of the Work shall be reflected, as well as Work Activities by utilities and other similarly involved third parties associated with the Work. The Contract Schedule shall include Work Activities or Milestones, but not be limited to the following: all design and pre-construction activities; specific Milestones for the start and completion for each stage of the Design Work; specific Milestones for when State and State agency information and reviews are required; submittal dates; production Milestones; early purchasing; key deliverables in Scope of Work; start of tenant programming (as applicable); Milestone for each Contract Phase; mobilization of personnel and equipment when required; sequence of operations; commissioning Work Activities; procurement of materials and equipment; and all contract close Work Activities such as Punch List and Operation Manuals.
11. The Critical Work Activities shall be identified, including critical paths for Contract interim and final completion Milestone dates.
12. All Work Activities shall be coded as called for in the Execution part. All Work Activities shall be coded at a minimum to reflect which Contract Phase they are associated with. Any Work Activity that may be involved in multiple Phases shall be broken into separate Work Activities to reflect each Phase such work occurs in, allowing Work Activities to be grouped by Contract Phase.
13. CM/Contractor shall not sequester float through strategies including extending Work Activity duration estimates to consume available float, using preferential logic, using extensive or insufficient crew/resource loading, use of float suppression techniques, special lead/lag logic constraints (unless specifically requested in writing to University's Representative and approved). Use of float time disclosed or implied by the use of alternate float suppression techniques shall not be for the exclusive use or benefit of either University or CM/Contractor. It is acknowledged that University-caused or CM/Contractor-caused time savings to Work Activities on or near the critical path will increase float. Such increase in float shall not be for the exclusive use or benefit of either University or CM/Contractor.

14. For all schedule submittals other than Look Ahead Schedules (paper copy only), CM/Contractor shall submit both paper copy as instructed by University's Representative; and provide a electronic file copy on 3.5 inch, 1.44MB floppy disk clearly labeled as to submittal description and date; and containing an exact copy of paper submittal. All file information shall be written to disk via utilizing the Primavera Project Planner back-up utility tools.

PART 2 - PRODUCTS

2.1 SCHEDULING SOFTWARE

A. All Preliminary Contract Schedule, The Recovery Schedule, Update Contract Schedule, And Fragnet Schedule Shall Be Prepared Utilizing Primavera Suretrak Version (Latest Version For Windows), Or Primavera Project Planner (Latest Version For Windows), Or Equal (No Known Equal) Which Is 100% Compatible With Primavera.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Proposed Contract Schedule:
   1. The initial Preliminary Contract Schedule shall be submitted within 30 days after of the Phase 1 Notice to Proceed; and shall be based on durations provided in the Bid Documents and Project Schedule Exhibit.
      a. The final submittal of the Preliminary Contract Schedule shall be submitted in time to allow University review and approval 45 days prior to required date for the University it exercise its Option for Phase 2 and 30 days prior to the desired date to release the first Bid Package for bidding.
      b. At any time the University's Representative determines that the CM/Contractor is not currently following an acceptable Contract Schedule, the CM/Contractor shall submit within 10 days of notification by the University's Representative an updated Contract Schedule.

B. Monthly Status Report/Updated Contract Schedule:
   1. CM/Contractor shall submit an updated Contract Schedule with a draft Monthly Status Report on the 25th day of each month, along with Variance Report and Status Narrative (described below).
   2. CM/Contractor shall review the draft Monthly Status Report with the University's Representative upon submittal, the purpose of this joint review is to reach agreement on the job status shown in the draft Monthly Status Report.
   3. Variance Report shall be submitted based on the updated Contract Schedule. The report shall include a description of all Work Activities completed during the preceding month, a description of progress made, and planned Work Activities listed as started but not completed on the updated Contract Schedule, and shall report all Work Activities that have been delayed 5 or more working days. The format of this report shall include:
      a. Work Activity code and description
      b. Scheduled early start/finish dates
      c. Current anticipated early start/finish dates
      d. Working days remaining to complete unfinished Work Activities
      e. Percentage complete of started Work Activities
      f. Total float for each Work Activity
   4. Status Narrative Report shall identify the Work actually completed and reflects the progress of all Work Activities within 10 working days of the critical path. The Status Narrative Report shall indicate forecasted progress in relation to interim and/or final completion

Milestone dates as specified in the Contract Documents, in terms of calendar days behind or ahead. Specific requirements of the Status Narrative Report are as follows:

a. Actual completion dates for Work Activities completed during the report period
b. Actual start dates for Work Activities started during the report period
c. Estimated start dates for Work Activities scheduled to start during the month following the report period.
d. Changes in the duration(s) of any Work Activities and/or logic changes to Work Activities, or Work Activities done in a different sequence from the Contract Schedule.
e. Identification of the current critical path(s) to the interim and/or final completion milestones.
f. Work Activities proposed to be added to the Contract Schedule.
g. Identification of any University approved Fragnet Schedule the CM/Contractor proposes to incorporate into the Contract Schedule.
h. Shall identify any variances or changes in the direct labor hour allocation, the cause, and the Work Activities affected, and shall provide an explanation of proposed corrective action to meet the planned allocation called for in the Contract Schedule.

5. Within 5 days of meeting with University's Representative to review draft Monthly Status Report, CM/Contractor shall submit Monthly Status Report reflecting any agreed modifications. Any revisions agreed to by University's Representative resulting in changes to the propose work plan of the CM/Contractor to the Contract Schedule, shall make the revised updated Contract Schedule a Preliminary Contract Schedule, and upon review and approval shall become the Contract Schedule.

C. Recovery Schedule:
1. If at any time it is determined by the University's Representative that the progress of the Work, based on the Contract Schedule, reflects progress that would complete any interim and/or final Contract Milestone dates later than called for in the Contract Documents, the University may require the CM/Contractor shall prepare and submit a Recovery Schedule within 14 days from notification from the University's Representative, or such shorter time period as may be reasonably requested by University's Representative. The Recovery Schedule shall address a new work plan to accomplish the Work within the Contract Time, and shall include and identify additional concurrent operations, logic and sequence changes, additional manpower, additional shifts, or overtime work.

D. Fragnet Schedule:
1. At any time that the CM/Contractor requests an extension of the Contract Time, in addition to other requirements in the Contract Documents, the CM/Contractor shall submit a Fragnet Schedule.
2. All other requirements of Contract Schedule shall apply to a Fragnet Schedule.

E. Look Ahead Schedules:
1. Shall be submitted at each progress meeting of the Work as outlined in the Scope of Work or as reasonably requested by the University's Representative.
2. Look Ahead Schedules shall be a time scaled bar chart based on the updated Contract Schedule showing the comparison planned work and actual work, and indicating the percentage complete for all Work Activities schedule within 4 weeks (or as requested by University's Representative) of both before and after the date of report/meeting.

F. As-Built Schedule:
1. The As-Built schedule shall be submitted with the Monthly Status Report; and shall reflect the information the CM/Contractor and University's Representative have agreed has occurred as actual as-built sequence of the Work.

G. Schedule Updating:
1. CM/Contractor shall update and review the updated Contract Schedule on a weekly basis.

3.2 SCHEDULE FORMAT/DATA

A. Work Activity Coding:
   1. The following activity codes and structure sequence shall be applied at a minimum for all Work Activities and Milestones; additional codes may be added/utilized by the CM/Contractor for its requirements:
      a. Contract Phase
      b. Work/Bid Package
      c. Design Package
      d. Specification Group
      e. Responsibility/Subcontractor
      f. Project Area
      g. Floor AreaChange Order number
   2. Project Phase
   3. Cost Breakdown item

B. Resource Loading:
   1. All Work Activities involving labor or major equipment shall be resource loaded indicating what is required to accomplish the Work Activity. Labor shall be defined to show crew type and size, so that total manpower is identified. Resource Loading information shall be updated after each Bid Package for University's review and approval.

C. Cost Loading:
   1. Provide unit cost for all resources identified in the Resource Loading; and provide cost for materials for the Work Activity. Any other cost should be added in accordance with the Cost Breakdown on a prorated basis such that when the schedule is grouped and totaled based on the Cost Breakdown that they match in cost per Cost Breakdown category. Cost Loading information shall be updated after each Bid Package for University's review and approval.

D. Schedule Calendars:
   1. All holidays and non-work periods shall be identified in the Contract Schedule's calendar. Two calendars shall be used; a defined work week; and a 24 – hour, 7 – day per week (for such continuous events like concrete curing, etc.).

E. Report Format/Distribution:
   1. The University's Representative shall provide format/distribution requirements for printing the Contract Schedule, Preliminary Contract Schedule, the Recovery Schedule, updated Contract Schedule, Fragnet Schedule, and As-Built Schedule; which the University's Representative may revise during the Project, but will not change the information requirements contained herein.

END OF SECTION

SECTION 01 32 80
ELECTRONIC DATA TRANSFER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Terms and Conditions for the transfer of Electronic Data to Contractor for use in preparation of Submittals, Record Documents, coordination drawings, and related documents to be produced by Contractor and submitted to University:
   1. **CONTRACTOR'S ACCEPTANCE OF ELECTRONIC DATA IN ANY FORM SHALL CONSTITUTE ACCEPTANCE OF THE TERMS AND CONDITIONS OF THIS SECTION, INCLUDING PAYMENT OF INDICATED FEES.**

B. The University and the Contractor acknowledge that established administrative procedures for management of construction Projects anticipate paper documentation and methods for the exchange of such documents. To the extent the administrative and procedural requirements of the Contract Documents are predicated on established practices the University and the Contractor agree to accept reasonable modifications to certain procedural requirements to facilitate electronic exchange of information and the use of digital media.

C. Submittals: Only a material original stamped and signed by the University's Representative shall be acceptable as an official record of the processed submittal. When directed, quantities of document submittals specified in the Contract Documents may be adjusted as permitted to facilitate utilization of electronic transfer of information.

1.2 TERMS AND CONDITIONS

A. In consideration of Contractor's request to the University to deliver certain Electronic Data for use on the Project, Contractor agrees to the following:
   1. Electronic Data includes but is not limited to, computer-aided design (CAD) files including native file formats (DWG) and drawing exchange formats (DXF), and files produced by word processing, spread sheet, scheduling, data base and other software programs. The Electronic Data may be provided in an original format produced by Design Professional or other University consultant, or an alternate, "translated" format as requested by other parties to this Agreement.
   2. The means by which the Electronic Data is transferred may include but are not limited to, electronic mail, File Transfer Protocol (FTP) sites, project websites, and disk copies transmitted between the parties to this Agreement. Contractor acknowledges that Electronic Data transferred in any manner or translated from the system and format used by Design Professional or other University consultant, to an alternate system or format is subject to errors that may affect the accuracy and reliability of the data and that the data may be altered, whether inadvertently or otherwise. Accordingly, the University and Design Professional make no warranty, express or implied, as to the accuracy of the information transferred. The Electronic Data are not the Bidding Documents and differences may exist between these electronic files and corresponding hard-copy Bidding Documents. University reserves the right to retain hard copy originals in addition to electronic copies of the Electronic Data transferred, which originals shall be referred to and shall govern.
   3. As consideration to University for the transfer of the Electronic Data, Contractor agrees that the University, University's Design Professional, and University's agents and consultants shall not be liable for and hereby waives all claims and agrees to indemnify and hold University harmless from all liabilities, losses, damages or expenses (including attorneys' fees) arising out of, or connected with: (1) the transfer of Electronic Data by any means; (2) the use, modification or misuse by parties other than University and Design Professional of the Electronic Data; (3) the limited life expectancy and decline of accuracy or readability of the Electronic Data due to storage; (4) any use of the Electronic Data by any third parties

receiving the data from other parties to this Agreement; or (5) the incompatibility of software or hardware used by University and Design Professional and the other parties participating in the Work.

4. The Electronic Data provided under the terms of this Agreement are the proprietary information of University. All Electronic Data shall be treated as confidential and shall not be disclosed to or shared with others without express, written consent from the University's.
5. The University shall issue the most current information available, but does not undertake the responsibility for providing updated information as the Project proceeds. Contractor may make a specific written request for such updated information as Contractor deems necessary, which University will then provide subject to the Terms and Conditions hereof.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Certificates
2. Shop Drawings, Product Data, and Samples
3. Refrigerant Management Documentation
4. Contractor Certification Form
5. Subcontractor Certification Form
6. Submittal Schedule

B. Definitions:
1. The terms “Shop Drawings” and Product Data” are defined in Article 3.12 of the General Conditions.
2. As used herein, the term “manufactured” applies to standard units usually mass-produced. The term “fabricated” means items specifically assembled or made out of selected materials to meet individual design requirements. Shop drawings shall establish the actual detail of all manufactured or fabricated items, indicate proper relation to adjoining Work, and amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure.
3. The terms "Shop Drawings" and "Product Data" are defined in Article 3.12 of the General Conditions.

C. Manufacturers’ Instructions: Where any item of Work is required by the Contract Documents to be furnished, installed, or performed in accordance with a specified product manufacturer’s instruction, Contractor shall procure and distribute the necessary copies of such instructions to University’s Representative and all other concerned parties, and Contractor shall furnish, install, or perform the Work in strict accordance therewith.

OR

Manufacturer’s Instructions: Where it is required in the specifications that materials, products, processes, equipment or the like to be installed or applied in accordance with manufacturer's instructions, directions or specification, or words to this effect, it shall be construed to mean that said application or installation shall be in strict accordance with printed instructions furnished by the manufacturer of the material concerned for use under conditions similar to those at the job site. Three (3) copies of such instructions shall be furnished to the University's Representative and his/her approval thereof obtained before work is begun.

D. The University's Representative or its Design Professional reserves the right to review and request the removal or redesign of manufacturers' trade marks and names on items of materials and equipment which will be exposed to view in the completed Work. Such removal or redesign shall be at no increase in Contract Sum.

E. Materials and equipment, for which Underwriters' Laboratories, Inc. standards have been established and their label service is available, shall bear the appropriate UL label.

1.2 CERTIFICATES

A. Certifications of Review and Coordination: Within 10 days of Notice to Proceed, submit completed Contractor Certification of Review and Coordination and all Subcontractor Certifications of Review and Coordination.

B. Certifications of Review and Coordination: As required by the General Conditions, perform a thorough review of the Contract Documents prior to commencing the Work. If there are no exceptions, write 'NO EXCEPTIONS" in the space provided.
   1. Complete a copy of the Contractor Certification of Review and Coordination Form following this Section.
   2. Require all subcontractors to perform a thorough review of the Contract Documents and complete a copy of the Subcontractor Certification of Review and Coordination Form following this Section.
   3. Review all completed Forms and resolve conflicting comments, if any, among the various parties so as to present a clear, concise view of items noted.
   4. Submitting the required certifications does not relieve the Contractor from responsibility to continue to immediately report new discrepancies, errors, omissions, conflicts, code violations, and improper use of materials discovered in the Contract Documents during the course of construction.
   5. Applications for Payment will not be processed by the University's Representative until all certificates have been received.

1.3 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. Shop drawings, product data, and samples, other than in connection with proposed substitutions, shall be submitted to University's Representative only when specifically required; and University's Representative will not review any other such submittals. Product data and samples for proposed substitutions shall be submitted to University's Representative in accordance with Section 01630. Contractor shall be responsible for obtaining such copies of shop drawings, product data, and samples as it may require for its own use. Submittals Not Required: No shop drawings of supplemental data are required unless specifically requested by the University or specified herein. No shop drawings shall be submitted unless specifically requested.
   1. Submittal Schedule:
      a. Refer to Specific Specification Sections for the list of submittals required under each section and indicate the required submittals on the attached Submittal Schedule for review by University's Design Professional. A schedule of submission of shop drawings, product data, and samples by Contractor ("Submittal Schedule"), and their processing and return by the University's Design Professional shall be agreed upon by both parties in order that the items covered by these submittals will be available when needed by the construction process and so that each party can plan its workload in an orderly manner. Submit Submittal Schedule no later than 30 days after Award of Contract.
      b. Contractor shall prepare the Submittal Schedule in the form as attached or similar form acceptable to the University's Representative, and coordinate it with the Contract Schedule. No submittals will be processed before the Submittal Schedule has been submitted to and accepted by University's Representative, except in such cases where the processing of submittals is required to maintain job progress before the acceptance of the Submittal Schedule.
      c. In preparing the Submittal Schedule, Contractor must first determine from the Contract Schedule the date a particular item is needed for the Work. Working backwards, Contractor will establish the number of days required for fabrication, shipment, placement, and similar activities to determine the date required for the first submittal.
      d. Allow 14-28 day duration for the University's Design Professional's initial review of submittals depending on the submittal/shop drawing and specification section. Allow 7 days for Design Professional to re-review revised or unapproved submittal/shop drawings.
      e. Contractor to indicate whether the submittal is a "Full" or "Partial" submittal on the schedule and on the submittal.
   2. Material List: Provide complete material list of products proposed for use. Submit Material Safety Data Sheets (MSDS) for Owner's use. Neither the University Representative nor its Design Professional will review MSDS.

3. Contractor's Review:
   a. Contractor Review: The shop drawings and supplemental data, when called for, shall be submitted as the instruments of the Contractor, even though they may have been prepared by a subcontractor, supplier, dealer, manufacturer, or by any other person, firm or organization. Prior to submission, the Contractor shall undertake his/her own review and stamp with his/her acceptance those shop drawings and supplemental data he/she is requested to submit to the University's Architect/Design Professional for his/her review. By accepting and submitting shop drawings and supplemental data, the Contractor represents that the Contractor has determined and verified all field measurements, the physical construction, the quality of materials, the applicability of catalog numbers, and similar data, or will do so, and that the Contractor has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. Conflicts with other trades shall be resolved by the Contractor in the shop drawings, if possible, but in any event prior to the actual construction. Drawings submitted in response to a request of the University's Architect shall show rearrangements, if any, made necessary by the use of materials or equipment other than those specified. Review, mark-up as appropriate, and stamp show drawings, product data, and samples prior to submission. Submittals shall clearly show that they have been reviewed and approved by Contractor for conformance with the requirements of the Contract Documents and for coordination with other Sections.
   b. Submittals not stamped and signed by Contractor will be returned without review.
   c. Determine and verify:
      1) Field measurements.
      2) Field construction criteria.
      3) Catalog numbers and similar data.
      4) Conformance with Contract Documents.
   d. Coordinate each submittal with requirements of the Work and of the Contract Documents.
   e. Notify University's Representative and its Design Professional in writing, at time of submission, of any changes in the submittals from requirements of the Contract Documents. Contractor is responsible to correct the deficiencies from the requirements of the contract documents when any changes are not made in writing to the University Representative or its Design Professional at the time of submission. The approval of submittals will be deemed null and void.
   f. Begin no fabrication or Work which requires submittals until the return of the University's Design Professional's final reviewed submittals.
4. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities as specified in Section 01 3300. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components.
   a. Show the relationship of components shown on separate Shop Drawings.
   b. Indicate required installation sequences.
   c. Comply with requirements contained in this Section.
5. BIM Procedures:
   a. Contractor shall establish procedures for coordinating work using BIM methods and protocols.
   b. Format and Development: Prepare coordination drawings according to the following requirements:
      1) Prepare BIM files for the project based on original hard copy documents as received from the University.
      2) Prepare all files using BIM software program, version, and operating system as approved by University.
      3) Prepare BIM Execution Plan establishing BIM protocols for project, including standards, responsibilities of Contractor and sub-contractors, schedules, clash detection, and quality control.

4) Designate a specific staff person as Contractor's BIM Coordinator.
5) Submit or post coordination drawing files using format same as file preparation format or Portable Data File (PDF) format.

c. Clash Detection:
1) Using BIM procedures perform clash detection as part of preparation of coordination drawings.
2) Include clash detection protocol in the BIM execution plan.
3) BIM Coordinator will review and assemble the various design and trade models, create clash reports and conduct coordination meetings with University's Representative as defined by the BIM execution plan.
4) Run Parameters: Clash detection, at minimum, shall be set to report any hard clashes within a 1 /4 inch tolerance. Clearance tolerances shall be used to account for additional material applied to modeled elements, such as fire proofing or required clearances.
5) At a minimum, review Clash Detection documents on a weekly basis. Identify conflicts requiring document modifications and review with University's Representative.
6) Update model elements based on field verification of dimensions and orientation.

d. Following resolution of conflicts and clash detection, prepare coordination drawings for review as follows:
1) Comply with shop drawing requirements for sheet size and submittal methods specified in Section 01 3300 "Submittals".
2) Refer to Specifications in Divisions 02-28 technical specification sections for specific Coordination Drawing requirements.
3) Provide composite coordination drawings for equipment and system installations in mechanical and electrical rooms and spaces where two or more entities will provide the work.
4) Provide composite coordination drawings showing planned locations of core cuts, sleeves, and other penetrations intended for placement in concrete decks, slabs, and structural components. Indicate intended use such as openings for conduit, piping, ducts, and utility services.
5) Provide composite coordination drawings showing planned locations of fire and sound rated wall penetrations, including dampers. Indicate intended use such as openings for conduit, piping, ducts, and utility services.
6) Prepare above-ceiling coordination drawings showing all above-ceiling work including structural members and required clearances and dimensions.

e. At the end of the project as part of the close out submittals the Contractor shall provide an "as-built" BIM model to be given to the University in addition to the hard copy as built drawings.

6. Submission Requirements:
a. Make submittals promptly in accordance with the Specifications and in such sequence as to cause no delay in the Work.
1) Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
a) Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
b) Coordinate transmittal of different types of submittals for related elements of the work so processing will not be delayed by the need to review submittals concurrently for coordination.
c) The University's Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

2) Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
   a) Allow sufficient time from receipt by University's Representative, for initial review and comment. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The University's Representative will promptly advise the Contractor when a submittal being processing must be delayed for coordination.
   b) If an intermediate submittal is necessary, process the same as the initial submittal.
   c) Allow additional time for reprocessing each submittal.
   d) No extension of Contract Time will be authorized because of failure to transmit submittals to the University's Representative sufficiently in advance of the Work to permit processing.

b. Number of Submittals Required: Refer to Specification Section 01 3200 "Document Control" for distribution of Shop Drawings and Product Data submittals. After each submittal has been reviewed by the Design Professional and returned to the Contractor. The Contractor shall make (two) 2 hard copies of all approved submittals and shall submit the hard copies to the University's Representative for project record filing.
   1) Samples: Contractor to submit a minimum of (five) 5 physical samples each of products and or samples for Design Professional's review and approval. After review and approval one sample will be retained by the architect, two (2) for the contractor and its subcontractor and two (2) for the University's Representative.
   2) Shop drawings and supplemental data, where called for, shall be prepared and submitted as per General Conditions. Final corrected copies of schedules and shop drawings or supplemental data to University's Design Professional for review shall be such as to provide one (1) for University's Architect's files, two (2) for the University and two (2) to the Contractor's job files and for distribution by the Contractor to subcontractors or vendors. Exceptions shall be as noted in Specifications sections.

c. Submittals shall contain:
   1) Identification data number assigned by the Contractor, consisting of the specification section number followed with the number 001 and continuing in sequence.
      a) Resubmittals: Add a letter to the previous identification, for instance 01 3400/005/R1 would be a first resubmittal.
      b) Use a separate number for each product, assembly, or system. Similar or related items may be grouped only if compatible with review process as approved.
   2) Date of submission and dates of any previous submissions.
   3) Project name and number, and contract identification.
   4) Names of Contractor, Subcontractor, Supplier and Manufacturer.
   5) Identification of item, with Specification Section number and article/paragraph references.
   6) Field dimensions, clearly identified as such.
   7) Relation to adjacent or critical features of the Work or materials.
   8) Reference standards, such as ASTM or Federal Specification numbers.
   9) Identification of changes from requirements of the Contract Documents.
   10) Identification of revisions on resubmittals.
   11) An 8-inch x 3 inch blank space for review stamps, as necessary.
   12) Contractor's stamp, initialed or signed, certifying to the review of the submittal; verification of materials and field measurements and conditions; and compliance of the information within the submittal with requirements of the Work and of the Contract Documents.

d. Interpretation of Terms:
   1) "As directed", "as required", "as permitted", "acceptable", "satisfactory", means by or to the University's Architect. The term "equal" means "equal in the opinion of the University's Architect after submittal data is reviewed". The term "favorable review" means that the submittals for material list, shop drawings, material substitutions, schedules, etc., will be reviewed by the University's Architect and copies returned to the Contractor marked as "Review Completed", "No Exceptions Taken" or "Make Corrections Noted" in which case no further submittals are needed.
   2) Submittals returned marked "Resubmit", "Amend and Resubmit" or "Rejected - Resubmit" shall be corrected to comply with project requirements and shall be resubmitted for review

7. Resubmission Requirements:
   a. Shop Drawings and Product Data:
      1) Revise shop drawings or product data, and resubmit as specified for the initial submittal, only if required by University's Design Professional.
      2) Identify any changes which have been made other than those requested.
      3) Note any departures from the Contract Documents or changes in previously reviewed submittals which were not commented upon by University's Design Professional.
   b. Samples: Submit new samples as required for initial submittal.
   c. University's Design Professional's Review: The University's Design Professional will review shop drawings and supplemental data submitted by the Contractor only for general design conformance with the concept of the Project and compliance with the information given in the Contract Documents. 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 or performance of equipment or systems, all of which remain the responsibility of Contractor as required by the Contract Documents.
8. Distribution:
   a. Reproduce and distribute copies of Submittals including Shop Drawings and Product Data, which carry the University's Design Professional's review stamp, to the following locations:
      1) Contractor's Project site file.
      2) Record documents file maintained by Contractor.
      3) Separate Contractors.
      4) Subcontractors.
      5) Supplier or manufacturer.
      6) Other involved parties as directed by University's Representative.
9. Design Professional's or Design Professional's designee's or University Representative's Review will be under the following conditions.
   a. Review of submittals is only for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. 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 instruction for installation for performance or equipment or systems, all of which remain the responsibility of contractor as required by the Contract Documents.
   b. The review does not affect the Contractor's responsibility to perform all Contract requirements with no change in Contract Sum or Contract Time. Any actions shown are subject to the requirements of the Drawings, Specifications and other Contract Documents. The Contractor is responsible to confirm and correlate dimensions at the site, for information that pertains to the fabrication processes, for the means, methods, techniques, procedures, sequences and quantities necessary to complete the Contract and for coordination of the work of all trades and satisfactory performance of his work. The review is undertaken solely to satisfy Consultant's obligations, if any to the

University and shall not give rise to any claim by the Contractor or other parties against the University's Representative, his/her Consultants or University.

B. Shop Drawings
1. Present information required on shop drawings in a clear and thorough manner. Identify details by reference to drawings and detail, schedule, or room numbers shown and specified.
2. Shop drawings shall be original drawings by the Contractor. Direct reproductions of the Contract Drawings will not be acceptable as shop drawings.
3. Shop Drawings Delineation: The Shop Drawings shall be drawn to scale and shall be completely dimensioned, giving the plan together with such sections as are necessary to clearly show construction detail.
4. Responsibility: These Shop Drawings and all supporting data, catalogs, etc., shall be prepared by the Contractor or his/her suppliers, but shall be submitted as the instruments of the Contractor. Therefore, the Contractor shall review and approve the drawings of his/her suppliers as well as his/her own drawings before submitting them to the University's Representative. In particular, the Contractor shall ascertain that the drawings meet all requirements of the Drawings and Specifications and also conform to the structural and space conditions. Each Shop Drawing submitted for review shall bear a stamp certifying that it has been reviewed and approved by the Contractor in accordance with the Contract Documents. If such Shop Drawings show variations from Contract Documents, whether because of standard shop practice or other reasons, the Contractor shall make special mention thereof in his/her letter of transmittal. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping, connections, wiring, manner of installation, etc., which may be required by the equipment he/she proposes to supply both as pertains to his/her own work and any work affected under other parts, heading or divisions of Drawings and Specifications.
5. Identification: Shop Drawings shall be entitled with the name of the project on each sheet and shall otherwise be identified by listing the particular division, section, article or reference of the work pertaining. Submit different items on separate sheets. All submittals shall be numbered sequentially.
6. Manner: Furnish for University's Design Professional's approval separate sheets of submittal of each specialty item in the following manner:
   a. Catalog cuts shall be photocopied or reproduced in some other acceptable manner and submitted on one (1) side only of an 8-1/2" x 11" sheet, noting only the items in question, together with the descriptive (specification) data complete. Once the Design Professional has reviewed the submittal provide two (2) hard copies of each approved, stamped shop drawing and other supporting data to the on-site University's Representative.
   b. Each sheet shall be identified with the division, section, article or reference in the Contract Documents which covers the item submitted for approval.
   c. Each sheet shall be identified with the project name, the University's Representative and the project's Design Professional.
   d. Each sheet shall bear the Contractor's stamp and signature of approval.
7. All shop drawings shall be drawn accurately suitable for duplicate copying by black line, blue line printing processes or photocopy.
8. Supplemental Data: Supplemental data shall include information as noted in the specification paragraphs requiring them, or as requested by the University.
9. Review Required: Shop drawings, if requested, must be submitted to and favorably reviewed by the University's Architect/Design Professional before being used by the Contractor on the job.

C. Product Data
1. Clearly mark each copy to identify pertinent Products or models.
2. Show performance data consisting of capabilities, rpm, kw pressure drops, design and operating pressures, temperatures, performance curves, noise level curves, power

characteristics and consumption; conforming as closely as possible to the test methods referenced in the plan and specifications.
3. Show dimensions, weights and clearances required.
4. Show wiring or piping diagrams and controls.
5. Modify the standard schematic drawings and other diagrams to delete information, which is not applicable to the Work.
6. Supplement standard information to provide information specifically applicable to the Work.

D. Samples:
1. Office samples shall be of sufficient size and quality to clearly illustrate the following:
   a. Functional characteristics of the products, with integrally related parts and attachment devices.
   b. Full ranges of color, texture, and pattern.
   c. Provide a minimum of5 samples plus any additional number for Contractor needs.
2. Samples herein referred to shall include all materials, equipment, surface textures, colors, fabrics, etc., as required by Drawings and Specifications or as requested by the University's Design Representative. They shall be submitted as required by the Specifications or requested by the University's Representative or its Design Professional.
3. Submittal: Samples, properly identified and described, shall be submitted as noted herein, or as may be required by the University's Representative. They shall be submitted and resubmitted until approved. No approval of a sample shall be taken in itself to change or modify any contract requirement. Finishes, materials, or workmanship in the completed building shall match the approved samples.
4. Manner: Contractor shall forward all samples under cover letter in five (5) copies, including a complete listing of such samples designated for use on the project, with complete identification on each sample by project name, ultimate destination of material, manufacturer, brand, lot, style, model, etc., Contract Document reference as well as the names of the Contractor, Supplier, Project, Design Professional and University's Representative. All submittals shall be numbered sequentially.
5. Return: Samples of value will be returned to the Contractor for use in the project after review, analysis, comparison and/or testing as may be required by the University's Architect.
6. Test Sample: Test samples, as the University's Representative designates, will be selected from the materials or equipment delivered by the Contractor for use in the work. If any test sample fails to meet the specification requirements, all previous approvals will be withdrawn and such materials or equipment which fail the testing shall be subject to removal and replacement by the Contractor with materials or equipment meeting the specification requirements.

1.4 REFRIGERANT MANAGEMENT DOCUMENTATION

A. UCR has instituted a requirement to comply with end-of-year refrigerant inventory for reporting to UCOP and with the South Coast Air Quality Management District's policies to account for the use of refrigerant gas delivery, recovery and charging installed with new HVAC and any other equipment using gas refrigerant on UCR projects.

B. To provide accurate accounting for the reporting of the refrigerant charge in a mechanical system and/or equipment, the actual quantity must be known in order to document gas lost from leaks etc. when repairs are done.

C. HVAC and other equipment utilizing gas refrigerant that are delivered to the site intact with the factory charge quantity listed on the nameplate or in literature submitted for the design professional's review, can sometimes be charged in the field according to various indications. Therefore the contractor who delivers and installs any system and/or equipment which uses refrigerant shall provide startup reports that list the exact quantity of gas charged into each

system and submit these reports to the University's Representative who will provide to UCR EH&S.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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CONTRACTOR CERTIFICATION

COMPLETE THIS CERTIFICATE, INCLUDING SIGNATURE BY PERSON DIRECTLY RESPONSIBLE FOR WORK ON THIS PROJECT. REVIEW EACH SUBCONTRACTOR CERTIFICATION FOR COMPLETENESS AND COORDINATION WITH COMMENTS MADE ON THIS CERTIFICATE AND OTHER SUBCONTRACTOR CERTIFICATES. SUBMIT THIS CERTIFICATE AND ALL SUBCONTRACTOR CERTIFICATES TO THE UNVERSITY'S REPRESENTATIVE WITHIN 10 DAYS OF RECEIVING NOTICE TO PROCEED**.**

1. As required by the General Conditions of the Contract for Construction, the undersigned certifies that a thorough review has been made of all of the Contract Documents, including, but not limited to the Agreement, General and Supplementary conditions, Drawings, specifications, and Addenda (if any) for the Work. The undersigned also acknowledges each subcontractor has been required to perform a similar thorough review and that Contractor and subcontractors have related and coordinated requirements of individual units of Work to requirements for the entire Work.

2. The undersigned acknowledges his/her obligation to identify below discrepancies, errors, omissions, conflicts, code violations, and improper use of materials discovered in the Contract Documents. Except as noted below and on subcontractor certificates, the undersigned certifies, to the best of his/her knowledge, information, and belief that the Work can be completed in a workmanlike manner without extensive modifications or additional expense.

EXCEPTIONS:_____
_____
_____
_____

NAME, ADDRESS, TELEPHONE OF
CONTRACTOR:_____
_____
_____
_____

AUTHORIZED
SIGNATURE:_____ DATE:_____

NAME (PRINTED CLEARLY OR TYPED):_____

TITLE:_____

END OF CONTRACTOR CERTIFICATION

APPROVED
UC RIVERSIDE
Office of Planning, Design & Construction Signed CBO: Gilbert Granados
Building, Safety and Compliance Division
CAMPUS BUILDING PERMIT

Reviewed
3/28/21

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SUBMITTAL SCHEDULE									
Section	Shop Dwgs	Prod. Data/List	Samples	Extend. Guarantee	Op/Maint. Manuals	Tests	Extra Mat'l	Certs.	Other
01325									
01630									
01 1100									
01 1400									
01 2300									
01 2613									
01 3113									
01 3119									
01 3200									
01 3280									
01 3300									
01 3520									
01 3543									
01 3546									
01 4100									
01 4200									
01 4300									
01 4500									
01 4516									
01 4520									
01 5100									
01 5200									
01 5300									
01 5400									
01 5500									
01 5600									
01 5700									
01 6000									
01 7100									
01 7329									
01 7400									
01 7700									
01 7839									
01 8113									
01 9113									

NOTE: Should a discrepancy arise between this schedule's requirements and individual requirements, the most stringent requirement shall prevail.

APPROVED
UC RIVERSIDE
Office of Planning, Design & Construction Signed C&D: Building, Safety and Compliance Division
CAMPUS BUILDING PERMIT

END OF SECTION

Received
01/03/2020

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SUBCONTRACTOR CERTIFICATION

COMPLETE THIS CERTIFICATE, INCLUDING SIGNATURE BY PERSON DIRECTLY RESPONSIBLE FOR WORK ON THIS PROJECT, AND SUBMIT TO THE GENERAL CONTRACTOR WITHIN 5 DAYS OF RECEIVING NOTICE TO PROCEED FROM GENERAL CONTRACTOR.

1. As required by the General Conditions of the Contract FOR construction, the undersigned certifies that a thorough review has been made of all of the Contract Documents, including, but not limited to the Agreement, General and Supplementary Conditions, Drawings, Specifications, and Addenda (if any) for the Work. The undersigned also certifies that Contractor and subcontractor have related and coordinated requirements for the entire Work.

2. The undersigned acknowledges his/her obligation to identify below discrepancies, errors, omissions, conflicts, code violations, and improper use of materials discovered in the Contract Documents. Except as noted below, the undersigned certifies, to the best of his/her knowledge, information, and belief that no such discrepancies, errors, omissions, conflicts, code violations, or improper use of materials occur in the Contract Documents.

3. Except as noted below, the undersigned has no objection to, or reservation about, the materials to be furnished or the conditions under which they will be installed, and is satisfied that contractual responsibilities for units of Work for which undersigned is responsible can be completed in a workmanlike manner without extensive modifications or additional expense.

EXCEPTIONS:_____
_____
_____

UNITS OF WORK FOR WHICH UNDERSIGNED IS RESPONSIBLE:
_____
_____

NAME, ADDRESS, TELEPHONE OF
SUBCONTRACTOR:_____
_____
_____
_____

AUTHORIZED
SIGNATURE: _____DATE:_____

NAME (PRINTED CLEARLY OR TYPED): _____

TITLE: _____

END OF SUBCONTRACTOR CERTIFICATION

APPROVED
UC RIVERSIDE
Office of Planning, Design & Construction Signed CBO: Gilbert Granados
Building, Safety and Compliance Division
CAMPUS BUILDING PERMIT

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SECTION 01 35 20
DESIGN ASSIST PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements of Contractor for design-assist work including, but not necessarily limited to, those identified in the various Sections of the Specifications and the following:
   1. Contractor's Responsibility
   2. Coordination with Architectural Design Intent

B. The following require design assistance:
   1. Fire sprinkler system.
   2. Fire alarm system.

C. Design-assist procedures are specified to assist Contractor in coordinating design-assist work.

1.2 CONTRACTOR'S RESPONSIBILITY

A. Contractor acknowledges that it shall be responsible for the design, method of construction, and coordination and integration with other trades to achieve the architectural design intent of the Contract Documents, of those portions of the design-assist work including sizing, sequence, placement and details of construction.

B. Contractor guarantees the following:
   1. Design-assist work shall be constructed in compliance with building codes and ordinances in effect and shall be fit and proper for its intended use.
   2. Where relevant, design and method of construction of the design-assist work shall not incorporate or employ the use of any product, process or technique which may be protected by common law or statutory patent, copyright or trade secret rights unless Contractor or subcontractor shall be the lawful owner or licensee of same.

C. Contractor shall indemnify and hold harmless University, University's Representative, Architect and it's consultants, and agents and employees of any of them from and against claims, damages and expenses resulting from breach or failure by Contractor to perform fully any of the forgoing obligations and specifically agrees to indemnify and hold University harmless from any and all claims of the Contractor's employees, agents, subcontractors, suppliers or third parties and to make good any damages to the Work, and attorneys' fees and costs of additional work by University's Design Professional resulting from the inadequacies of the design, techniques or methods of construction of the design-assist Work.

D. The design and the drawings and specifications for the techniques and method of construction of the design-assist work shall be prepared and shall result in work which is fit to perform its intended purpose.

E. For design-assist work, Contractor shall provide plans, specifications, and calculations that are prepared, stamped, and signed by qualified, registered, licensed engineers authorized to practice their professions under the laws of the State of California. The plans, specifications, and calculations shall be acceptable to the University's Representative.

F. Prior to commencement of the design-assist work at the Project Site, Contractor shall provide the University with copies of current insurance policies covering the errors or omissions of persons designing the design-assist work with maximum deductibles and limits per occurrence as mutually agreed by the University and Contractor, together with an endorsement providing for a 30-day notice to University prior to cancellation or material reduction in coverage.

G. Maintain insurance at least the period equal to the applicable statute of limitations for claims arising out of latent defects in works of improvement to real property, if such insurance is not written on an "occurrence" basis during the time the design-assist work is designed and constructed.

1.3 COORDINATION WITH ARCHITECTURAL DESIGN INTENT

A. Ceilings:
   1. Coordinate the work of all trades involved to ensure clearances for fixtures, ducts, piping, ceiling suspension systems and other above-ceiling work as necessary to maintain finished ceiling heights.
   2. Paint all exposed items at ceilings. Paint air grilles to match adjacent ceiling finish.
   3. Locate light fixtures, sprinkler heads, and diffuser grilles in the center of ceiling panels.

B. Areas Where Structure Is Exposed:
   1. Install sprinkler lines, ductwork, conduit, plumbing, process piping, lighting and all other overhead items at regular intervals, parallel to and/or perpendicular with building column grid lines.
   2. Align all hangers, wires, braces, struts, chains, junction boxes, etc. in any given line aligned with one another, and install in the same fashion, for a neat, uniform appearance.

C. Review proposed layouts with University's Representative and other trades in the field prior to commencing work. Layouts which have not been so reviewed will be subject to change at no additional expense to the University if found unsatisfactory. Areas subject to such review include but are not necessarily limited to exposed structure areas.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

SECTION 01 35 43
ENVIRONMENTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Hazardous Materials Procedures
   2. Toxic Materials Procedures
   3. University of California – Approved TSDFs (Attached to end of Section.)

B. Submittals:
   1. Submit Material Safety Data Sheets (MSDS) for all materials, whether existing or incorporated into the work, which are identified as potentially hazardous but not required to be abated.

1.2 HAZARDOUS MATERIALS PROCEDURES

A. Except as otherwise specified, in the event Contractor encounters on the Project site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), or other hazardous materials which have not been rendered harmless, Contractor shall immediately stop Work in the area affected and report the condition to University and University's Representative in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of University and Contractor if in fact the material is asbestos, PCB, or other hazardous materials and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos, PCB, or other hazardous materials, or when such materials have been rendered harmless.

B. If material has been encountered on site and the Contractor has reported the condition to the University's Representative, then the University Representative shall contact UCR Environmental Health and Safety office (EH&S) and **Ambient Environmental**, the University's hazardous material consultant to conduct an on-site assessment of the material and if it is found to be hazardous then **Ambient Environmental** shall prepare a plan to remove it off site and dispose of it at a University of California approved Treatment, Storage, and Disposal Facility (TSDF). See the list of University of California – Approved TSDFs attached to the end of this Section.

1.3 TOXIC MATERIALS PROCEDURES

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

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University of California - Approved TSDFs

Building Permit B19-337

This document is a list of permitted treatment, storage, and disposal facilities (TSDFs) that have been deemed acceptable for use in managing hazardous waste generated by the University of California (UC) or at UC facilities. Neither UC nor any of its employees makes any warranty, express or implied, as to the merchantability or fitness for a particular purpose of the goods or services provided by the TSDFs listed above. Except as stated above, reference to the TSDFs in this document does not necessarily constitute or imply its endorsement or recommendation by UC and UC expresses no opinion as to any TSDF that does not appear in this document. This document shall not be used for advertising or product endorsement purposes or for any other use not expressly authorized in writing by UC.

TSDF name	Street	City	State	Zip	phone	EPA ID
Altamont Landfill	10840 Altamont Pass Road	Livermore	CA	94550	(925) 455-7306	CAD981382732
AERC INC (MTI)	30677 Huntwood Avenue	Hayward	CA	94544	(510) 429-1129	CAD982411993
Azusa Land Reclamation Co.	1201 W. Gladstone	Azusa	CA	91702	(626) 334-0719	CAD009007626
Bethlehem Apparatus	890 Front Street	Hellertown	PA	18055	(610) 838-7034	PAD002390961
Chemical Waste Management (CWM) - Kettleman Hills	35251 Old Skyline Roac	Kettleman	CA	93239	(559) 386-9711	CAT000646117
Chemical Waste Management (CWM) - TWI	7 Mobile Drive	Sauget	IL	62201	(618)271-2804	ILD098642424
Chem-Nuclear Systems, Inc (Barnwell)	140 Stoneridge Drive	Columbia	SC	29210	(803) 758-1826	SCD048372429
Clean Harbors (Aragonite), LOC Inc.	P.O. Box 22890	Aragonite	UT	84122	(801) 323-8100	UTD981552177
Clean Harbors (Chicago)	11800 S. Stony Island Ave.	Chicago	IL	60617	(800)678-4844	ILD000608471
Clean Harbors (Deer park), Inc	2027 Battleground Road	Deer Park	TX	77536	(713) 930-2300	TXD055141378
Clean Harbors (Kimball, Incinerator Facility)	2247 S. Highway 71	Kimball	NE	69145	(308)235-4012	NED981723513
Clean Harbors (Lokern)	2500 West Lokern Rd.	Buttonwillow	CA	93206	(805) 762-6200	CAD980675276
Clean Harbors (Los Angeles), Inc.	5756 Alba Street	Los Angeles	CA	90058	(213) 585-5063	CAD050806850
Clean Harbors (Phoenix)	1340 West Lincoln Street	Phoenix	AZ	85007	(602)258-6155	AZD049318009
Clean Harbors (Sacramento)	6000 - 88th Street	Sacramento	CA	95828	(916) 386-4999	CAD000084517
Clean Harbors (San Jose)	1040 Commercial St. Suite 109	San Jose	CA	95112	(408) 453-6046	CAD059494310
Clean Harbors (Spring Grove Resources Recovery)	4829 Spring Grove Ave.	Cincinnati	OH	45232	(513)681-5738	OHD000816629
Crosby & Overton, Inc.	1630 W 17th Street	Long Beach	CA	98013	(562) 432-5445	CAD028409019
DeMenno/Kerdoon	22000 N. Alameda Street	Compton	CA	90222	(310)537-7100	CAT080013352
Diversified Scientific Services (DSSI)	P.O. Box 863	Kinston	TN	37831	(615) 376-0084	TND982109142
Duratek	1560 Bear Creek Road	Oak Ridge	TN	37831	(423) 481-0222	TND982157570
ENSCO	309 American Circle	El Dorado	AR	71730	(870) 862-0272	ARD069748192
ENSCO West	1737 East Denni Street	Wilmington	CA	90744	(310) 835-9997	CAD044429835
Envirocare of Utah, Inc	US I-80, Exit 49	Clive	UT	84029	(801) 532-1330	UTD982598898
Environmental Management & Controls (EMC)	3106 South Faith Home Road	Turlock	CA	95380	(209)-667-1102	Radioactive Material License # 3546-5(
Envirosafe	hwy 78 Missile Base Roac	Grand View	ID	82624	(208)834-2275	IDD073114654
Heritage Environmental Services, Inc	7901 West Morris Street	Indianapolis	IN	46231	(317) 243-0811	IND093219012
Heritage Environmental Services, LLC	5122 East Story Road	Coolidge	AZ	85228	(520)723-4167	AZD081705402
Heritage Landfill	4370 W.CR 1275N	Roachdale	IN	46172	(317)243-0811	IND980503890
Kinsbursky Brothers Incorporated	1314 Lemon Street	Anaheim	CA	92801	(714)738-8516	CAD088504881
Mercury Waste Solutions, Inc.	21211 Durand Avenue	Union Grove	WI	53182	414-878-2599	WIR 000 000 356
Merry X-Ray	131 South Maple #1	S. San Fran	CA	94080	(650)6742-6630	CAL000512065
ONYX (formerly AETS)	1125 Hensley Street	Richmond	CA	94801	(510) 233-8001	CAT080014079
Onyx (formerly CWM OSCO)	1704 W. First Street	Azusa	CA	91702	(626) 815-2215	CAD008302903
Onyx (Superior Special Services, Inc.)	5736 West Jefferson	Phoenix	AZ	85043	(602) 233-2955	AZD983473539
Perma-Fix (Quadrex)	1940 NW 67th Street	Gainesville	FL	32653	(405) 468-2000	FLD980711071
Philip Environmental (Burlington)	20245 - 77th Avenue, south	Kent	WA	98032	(206) 872-8030	WAD991281767
Philip Environmental (Georgetown)	734 Lucile Street	Seattle	WA	98108	(206) 762-3362	WAD000812909
Philip Environmental (Rho-Chem)	425 Isis Avenue	Inglewood	CA	90301	(213) 776-6233	CAD008364432
Photo Waste Recycling Co., Inc.	2980 Kerner Boulevard	San Rafael	CA	94901	(415)459-8807	CAD981429673
Photo Waste Recycling Co., Inc.	12898 Bradley Avenue, Suite B	Sylmar	CA	91342	(818)362-0668	CAD000121946
Ramos Environmental Services Inc.	1515 South River Road	W. Sacramento	CA	95691	(916)-371-5747	CAD044003556
Romic Environmental Technologies Corp	2081 Bay Road	East Palo Alto	CA	94303	(650)-324-1638	CAD009452657
Romic Environmental Technologies Corp (Southwest)	6760 West Allison Road	Chandler	AZ	85226	(602) 796-1040	AZD009015389
Ross Environmental Services	36790 Giles Road	Grafton	OH	44044	(440) 748-5800	OHD 048415665
Stericycle, Inc. (Formerly BFI)	4135 West Swift Avenue	Fresno	CA	93722	(559)275-0991	None
Stericycle, Inc. (Formerly BFI)	90 North 1100 West	North Salt Lake	UT	84054	(801) 295-1555	UTD988078150
Systech Environmental Corp.	South Cement Road	Fedonia	KS	66736	(316) 378-4451	KSD980633259
SET Environmental INC. (Treatment One)	5743 Chestwood	Houston	TX	77087	(713)645-8710	TXD055735388
U.S. Filter Recovery Services (Norris Environmental)	5375 South Boyle Ave.	Los Angeles	CA	90058	(213) 277-1500	CAD097030993
Von Roll America (WTI)	1250 Saint George Street	East Liverpool	OH	43920	(800) 403-4888	OHD980613541
Waste Control Speciaists (WCS)	1710 West Broadway	Andrews	TX	79714	(713) 944-5900	TXD988088464
Pacific Resource Recovery Services		Big Bear	CA			CAD008252405

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SECTION 01 35 46
INDOOR AIR QUALITY (IAQ) PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section includes, without limitation, the following:
   1. IAQ Submittals
   2. Quality Assurance
   3. IAQ Management During Construction
   4. Sequence of Finish Installation

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

1.2 SUMMARY

A. Indoor Air Quality Procedures include:
   1. IAQ Management Plan During Construction:
      a. Procedures to prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.
   2. Sequence of Finish Installation: Scheduling/sequencing requirements and procedures necessary to optimize Indoor Air Quality (IAQ) levels for the completed Project.

B. Related Work Specified in Other Sections:
   1. Section 01 5700, " Temporary Controls" for environmental-protection measures during construction and location of waste containers at Project site.
   2. Section 01 7400, "Cleaning and Waste Management" for handling requirements of construction waste.
   3. Application Sections for indoor air sampling prior to occupancy. (Sections to be identified)

1.3 IAQ SUBMITTALS

A. IAQ Construction Management Plan. Submit 5 copies of plan within 30 days of date established for commencement of the Work.
   1. Include a schedule of all IAQ-related construction activities in the IAQ Construction Management Plan submittal.
   2. Update plan as required during the construction process to reflect Project conditions.

B. Meeting Minutes: Submit minutes from Contractor meetings related to the execution and verification of the IAQ Construction Management Plan.

C. Project Photographs: Submit to document IAQ measures implemented.

D. Product Data: Submit cut sheets of filtration media proposed for use.

E. LEED Submittal: LEED letter template for Credit EQ 3.1, signed by Contractor, with copy of plan and a statement that requirements for the credit have been met.

1.4 QUALITY ASSURANCE

A. Comply with the requirements of LEED Credit EQ 3.1, “Construction IAQ Management Plan During Construction.”

B. Contractor’s Plan shall meet or exceed the recommended design approaches of SMACNA’s “IAQ Guidelines for Occupied Buildings Under Construction,” (1995 Edition, Chapter 3).

C. IAQ Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Review methods and procedures related to IAQ management during construction.
   2. Review IAQ management requirements for each trade.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 IAQ MANAGEMENT DURING CONSTRUCTION

A. General: Contractor's IAQ Construction Management Plan shall include procedures to prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.
   1. Contractor's detailed plan shall be based on the particular characteristics of the Project, and include the items listed in this Section as a minimum.
   2. The IAQ Management Plan shall highlight the five requirements of the Sheet Metal and Air Conditioning National Design/Builders Association (SMACNA), "IAQ Guidelines for Occupied Buildings Under Construction," 1995, Chapter 3 and shall embody the principles and practices set forth hereinafter.
   3. Subcontractors and their employees shall be provided instruction and training in the IAQ Management Plan.

B. Plan Implementation:
   1. Implement waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
   2. Comply with Section 01 5700 for operation, termination, and removal requirements.

C. Monitoring of IAQ Plan:
   1. Hold weekly Contractor Site Co-ordination Meetings with the superintendents of all trade contractors. Review the appropriate components of the IAQ Construction Management Plan as a regular action topic at these meetings, and update the Plan as required. Document the implementation of the Plan in the meeting minutes. As a recording format, use SMACNA IAQ Guidelines Appendix C (Planning Checklist) and Appendix D (Inspection Checklist) as a guide.
   2. Take a specific series of record photographs at the appropriate stages to document adherence with the IAQ requirements. Submit at least 18 photographs (six photos taken on three different occasions during construction) along with identification of the SMACNA approach featured by each photo, in order to show consistent adherence to the LEED Credit requirements.

D. HVAC Protection:
   1. Store HVAC equipment in a clean, dry location. Until HVAC equipment (ducting, registers, air handler VAV boxes components, fans, and motors) has been installed, it shall be kept covered and secured with plastic film or in a location where it will not be exposed to moisture, dust, or other contaminants.
   2. Seal off all louvers and air intake/discharge points to prevent construction dust and debris from entering.
   3. Seal off all ductwork openings and air outlets with plastic sheeting to protect the duct system from dust and debris. Do not re-open until the end of activities that produce dust or pollution, such as drywall sanding, concrete cutting, masonry work, wood sawing, and so forth.
   4. Seal all HVAC inlets and outlets. Use of the HVAC system shall be avoided during construction until drywall construction is complete. Temporary ventilation may be installed to remove contaminants. All air inlets and outlets shall be sealed securely with tape during

construction. These include, but not limited to, outside air inlets, grilles, diffusers, supply ducts, return ducts, ceiling plenums, VAV (variable-air volume) plenum intakes, exhaust ducts, and window ventilator or air conditioning units. Openings shall be sealed with plastic film and tape that can be removed cleanly.

5. Seal HVAC components during installation. For ducting runs that require several days to install, sections shall be sealed off as they are completed. Seals shall be removed prior to continuing the ducting run. Other components of the HVAC system shall be subjected to the same requirements to protect them from contamination.
6. Use temporary filtration media. If the HVAC system is to be used while construction work is being done, temporary filtration media shall be installed on all intakes. Such filtration media shall have a minimum filtration efficiency (Minimum Efficiency Reporting Value-MERV per ASHRAE 52.2) of 8 or higher. For air intakes into parts of a building that are very sensitive to dust contamination, such as computer rooms, filtration media with a MERV rating of 13 or higher is required. New filtration with a MERV rating of 13 or higher shall be installed after construction.
7. If, for some unforeseen reason, there should arise a circumstance wherein the return air system is required to be used during the construction phase, install temporary MERV 8 filters or higher (as determined by ASHRAE Standard 52.2-1999) at each return air opening and provide frequent inspection and maintenance. If inspections by University Representatives reveal that the ductwork has become contaminated due to inadequate protection, the ductwork shall be cleaned professionally prior to the first phase of occupancy, using procedures established in ACR 2005 published by the National Air Duct Cleaners Association.
8. Under no circumstances shall air be returned from a construction area and then re-circulated through the permanent supply ductwork, unless and until the level of construction in the relevant area involves final finishes and trim and the construction has reached a point of complete building dry-in with no sanding and is free from dust, debris, and contaminants.
9. Do not use fan rooms to store construction or waste materials, and keep them clean and neat.
10. Inspect filters regularly. When the HVAC system is being used during construction and temporary filters are installed, filters shall be inspected weekly and replaced as needed.
11. Avoid contaminated air entry into enclosed parts of the building. When outdoor construction activities generate dust, combustion emissions, or other contaminants, operable windows and outside air supplies to enclosed portions of the building shall be closed.

E. Source Control:
1. Limit construction traffic and motor idling in the vicinity of air intake louvers when the HVAC systems are activated. Restrict motor vehicles to the loading dock area, well-removed from air intakes, preventing emissions from being drawn into the building.
2. Use electric or natural gas alternatives for gasoline and diesel equipment where possible and practical.
3. Cycle equipment off when not being used or needed.
4. Avoid the use of materials and products with high VOC and/or particulate levels. Use products and installation methods with low VOCs such as paints, sealers, sealants, filler materials, insulation, adhesives, caulking and cleaners. Comply with the requirements in other specification sections.
5. Keep containers of wet products closed as much as possible. Cover and seal waste materials which can release odor or dust.
6. Protect all materials, especially absorbent materials such as insulated ductwork, against moisture during delivery to and storage at the job site. Store materials inside the structure in a dry and clean environment pending installation. Building materials shall be kept dry to avoid the introduction of moisture into the building interior.
7. Avoid the use of moisture-damaged materials. Any porous materials that have been wetted shall be dried thoroughly before installation. Any porous materials that have been damaged, remained wet longer than 48 hours, or show signs of visible mold shall be discarded.

8. Ensure that the construction process will not result in moisture intrusion. In the event of rain or groundwater gaining entry to the building interior during construction, notify the University.
9. Avoid tracking pollutants into work areas.
    a. Once the framing and mechanical system installation starts, access to the building interior shall be controlled to minimize the tracking in of contaminants.
    b. Material deliveries and construction waste removal shall be routed via the most direct route to the building exterior of the building rather than through the space.
    c. Provide rough track-off grates or matting at the entryway to remove moisture and contaminants from workers shoes.
    d. Prevent the ingress of rodents and pests.
    e. Use procedures to ensure that there is no smoking inside the building.

F. Pathway Interruption:
1. Use dust curtains or temporary enclosures to prevent dust from migrating to other areas when applicable. During construction, isolate areas of work to prevent contamination of clean or occupied areas.
2. Keep pollutant sources as far away as possible from ductwork and areas occupied by workers when feasible.
3. Isolate work areas and/or create pressure differentials to prevent the migration of contaminants.
4. Use portable fan systems to exhaust contaminated air directly to the outside of the building, and discharge the air in a means to prevent it from re-entering.

G. Housekeeping:
1. Minimize accumulation of dust and other contaminants. Construction practices shall be used that minimize the production of dust and other contaminants from construction activities. Use integral dust-collection systems on drywall sanders, cut-off saws, and routers. Confine dust-generation activities to areas where clean-up can be carried out easily and contaminants will not be tracked to other areas.
2. Suppress Dirt. Wetting agents or sweeping compounds shall be used to deep dust from becoming airborne.
3. Clean up dust. Wet clothes, damp mops, wet scrubbers, and vacuum cleaners with high-efficiency particulate (HEPA) filters shall be used to clean up dust generated by construction activities.
    a. Cleaning frequency shall be increased when dust accumulation is noted.
    b. Institute cleaning activities of building areas on a daily basis, and of HVAC equipment as required.
4. Keep all coils, air filters, dampers, fans, and ductwork clean during installation, and clean them as required prior to performing the testing, adjusting and balancing of the systems.
5. Clean up spills. All spills and excess applications of solvent-containing products should be cleaned up using approved methods as soon as practicable. Water spills shall be mopped up promptly.
6. Keep work area dry. Avoid accumulations of water inside the building, and promptly remove any that may occur.
    a. Especially protect porous materials such as insulation and ceiling tiles from exposure to moisture.
    b. The entire area shall be kept as dry as practicable by promptly repairing any leaks that allow rainwater entry and mopping up any water accumulation.
    c. Use dehumidification if necessary for prompt drying of wetted spaces. Unvented combustion (e.g., propane of diesel “salamander” space heaters) shall not be used.
7. Seal containers containing volatile liquids. Containers of fuel, paints, finishes, and solvents shall be kept tightly sealed and preferably stored outside of the building when not in use.

H. Scheduling:
1. Comply with the scheduling requirements of Article, "Sequence of Finish Installation" of this Section.
   a. Schedule the installation of porous materials only after closing in building.
   b. Porous materials, such as insulation, fireproofing, and drywall shall not be installed in a building open to the weather.
   c. To avoid potential contamination of porous or absorbent materials such as ceiling tiles, install furnishings after interior finishes (drywall, paint, and floor finishing) have cured.
2. Phased Completion: Implement IAQ control measures in each tenant area until construction in that area is complete. Do not allow contaminants from an area under construction to enter the HVAC ductwork systems or to migrate to completed areas.
3. Filters:
   a. Install new MERV 13 filters at the central fan system, immediately prior to the first phase of building occupancy.
   b. Install new MERV 13 filters at fan systems serving limited areas immediately prior to occupancy for each respective area.

I. Ventilation:
1. Provide adequate ventilation during curing period. To aid in curing of interior finishes and other products used during construction and to remove pollutants after drywall installation is complete, provide adequate ventilation with 100% outside air, and proper filtration. In humid periods or when very high-moisture materials are present, supplementary dehumidification may be required during this curing period.
2. Flush-Out: Comply with the requirements of LEED credit EA 3.2.

3.2 SEQUENCE OF FINISH INSTALLATION

A. Sequence of Finish Installation: Project schedule shall address construction scheduling/sequencing requirements and procedures necessary to optimize Indoor Air Quality (IAQ) levels for the completed Project.
1. Scheduling: Contractor's Project Schedule for finish applications should allow for:
   a. Dissipation of high emissions from finishes that off-gas perceptible quantities of deleterious material during curing.
   b. Separation of off-gassing effects from the installation of adsorptive materials that would act as a "sink" for storage and subsequent release of these unwanted substances into building spaces and mechanical systems after project occupancy.
2. When Contractor's "Project Schedule" requires less than optimal sequencing of finish installation, related to IAQ, provide supplemental filtered "fresh air" ventilation of work areas during construction and restrict / control the use of permanent building mechanical systems prior to Owner acceptance of building to prevent contamination of systems by construction wastes and other deleterious substances.

B. Finish Types:
1. Type 1 Finishes: Materials and finishes which have a potential for short-term levels of off-gassing from chemicals inherent in their manufacturing process, or which are applied in a form requiring vehicles or carriers for spreading which release a high level of particulate matter in the process of installation and/or curing. Type 1 Finishes include, but are not limited to the following:
   a. Composite wood products, specifically including particleboard from which millwork, wood paneling, doors or furniture may be fabricated.
   b. Adhesives, sealants, and glazing compounds, specifically those with petrochemical vehicles or carriers.
   c. Wood preservatives, finishes, and paint.
   d. Control and/or expansion joint fillers.
   e. All hard finishes requiring adhesive installation.
   f. Gypsum board and associated finish processes.
   g. Sealants and associated filler materials.

2. Type 2 Finishes: "Fuzzy" materials and finishes which are woven, fibrous, or porous in nature and tend to adsorb chemicals off-gassed by Type 1 finishes or may be adversely affected by particulates. These materials become "sinks" for deleterious substances which may be released much later, or collectors of contaminants that may promote subsequent bacterial growth. Type 2 Finishes include, but are not limited to the following:
   a. Carpet and padding.
   b. Fabric wallcovering.
   c. Insulation exposed to the airstream.
   d. Acoustic ceiling materials.
   e. Fabric covered acoustic wall panels.
   f. Upholstered furnishings.
3. Materials that can be categorized as both Type 1 and Type 2 materials shall be considered to be Type 1 materials.

C. Optimal Order of Installation: Apply all Type 1 interior finishes throughout the entire controlled air zone of each enclosed building or building segment and allow such finishes to completely cure according to intervals and times stated in respective finish manufacturer's printed instructions before commencing installation of any Type 2 materials in the same area.
   1. Do not store any Type 2 materials in areas where installation or curing of Type 1 materials is in progress.

D. Materials Test Data - Required For Substitutions Only:
   1. All manufacturers/producers of materials listed below that are proposed for substitution on this Project are required to provide test data for their materials which show permanent, in-place Indoor Air Quality performance in accordance with requirements of this Specification.
   2. Material Safety Data Sheets: Review all MSDS's of materials to be submitted for testing as well as MSDS's for other products where specifically requested in this Project Manual and identify those classified as "Prohibited Materials".
   3. Prohibited Materials:
      a. Any building materials or products that emit pollutants included on the International Agency for Research on Cancer (IARC) "List of Chemical Carcinogens", the "Carcinogen List" of the National Toxicology Program, and the "Reproductive Toxin List" of the "Catalog of Teratogenic Agents" must have approval in writing from the Owner’s Representative before that building material or product may be used on this Project.
      b. Carcinogens: Use of materials emitting carcinogens will not be permitted unless a suitable substitute is not available. Do not proceed with procurement of any carcinogen emitting product or material without prior review and written approval of the University’s Representative.

END OF SECTION

SECTION 01 41 00
REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Applicable Codes, Regulations, and Authorities
2. Regulatory Notifications
3. Permit Requirements, Notifications, and Certificates
4. Fees – Not Used

B. References in the Specifications to "code" or to "building code," not otherwise identified, shall mean the foregoing specified codes, together with the additions, changes, amendments, and interpretations adopted by the enforcing agency and in effect on the date of these Contract Documents. Nothing on the Drawings or in the Specifications shall be interpreted as requiring or permitting work that is contrary to these rules, regulations, and codes.

C. Where other regulatory requirements are referenced in these Specifications, the affected work shall meet or exceed the applicable requirements of such references.

D. Nothing stated in this Section of the Specifications or other Sections of the Specifications, the other Contract Documents or shown on the Drawings shall be construed as allowing Work that is not in strict compliance with all applicable Federal, State, regional, and local statutes, laws, regulations, rules, ordinances, codes and standards.

E. Regulatory requirements referred to shall have full force and effect as though printed in these Specifications.

F. Discrepancies between these codes/rules/etc. and the Contract Documents shall be brought to the attention of the University's Representative for resolution. Unless otherwise directed by the University's Representative, if a conflict exists between referenced regulatory requirements and the Contract Documents, comply with the one establishing the more stringent requirements.

1.2 APPLICABLE CODES, REGULATIONS, AND AUTHORITIES

A. All applicable federal, state, and local laws and the rules and regulations of governing utility districts and the various other authorities having jurisdiction over the construction and completion of the Project, including the latest rules and regulations of the state fire marshal, OSHA, and the California Labor Code, shall apply to the Contract throughout, and they shall be deemed to be included in the Contract the same as though printed in these Specifications.

B. Codes and regulations that apply to this Project include, but are not limited to, the following including additions, changes, and interpretations adopted by the enforcing agency in effect as of the date of these Contract Documents.
1. California Code of Regulations (CCR):
a. Title 8, Industrial Relations
b. Title 17, Public Health
c. Title 19, Public Safety
d. Title 20, Public Utilities and Energy
e. Title 21, Public Works
f. Title 22, Environmental Health
g. Title 24: Building Standards Code
1) Part 2, California Building Code
2) Part 3, California Electric Code
3) Part 4, California Mechanical Code

4) Part 5, California Plumbing Code
5) Part 6, California Energy Code
6) Part 7, California Elevator Safety Construction Code
7) Part 9, California Fire Code
8) Part 11, California Green Building Standards Code
9) Part 12, California State Reference Standards

2. In addition to the above, work shall comply with the following:
   a. California Environmental Quality Act (CEQA).
   b. California Health and Safety Code.
   c. California Occupational Safety and Health Act Standards (Cal-OSHA).
   d. California Department of Transportation (Caltrans): Standard Specifications, latest edition.
   e. National Fire Protection Association (NFPA): Standards 13, 14, 24, 72, and 80.
   f. Americans with Disabilities Act - Title II (ADA).
   g. Federal Occupational Safety and Health Act (OSHA).
   h. Federal Environmental Protection Agency – Clean Air Act.
   i. Storm Water Pollution Prevention Act.
3. All work shall meet or exceed code and regulatory requirements.

C. Copies of Regulations: Obtain copies of the following regulations and retain at the Project site to be available for reference by parties who have a reasonable need:
1. California Code of Regulations, Title 8, 9 and 19
2. California Code of Regulations, Title 24, including:
   a. Part 1, California Administrative Code
   b. Part 2, California Building Code, Volumes 1 and 2
   c. Part 3, California Electrical Code
   d. Part 4, California Mechanical Code
   e. Part 5, California Plumbing Code
   f. Part 6, California Energy Code
   g. Part 7, California Elevator Safety Construction Code
   h. Part 9, California Fire Code
   i. Part 11, California Green Building Standards Code
   j. Part 12, California Referenced Building Standards Code
3. California Health and Safety Code regulations as referenced in the specifications.
4. CAL/OSHA Construction Safety Orders.
5. City of Riverside "Department of Public Works Standards and Specifications.
6. ~~National Electrical Code.~~ Covered by Part 3
7. National Fire Protection Association standards as referenced within the specifications
8. State of California, Department of Transportation, Division of Highways, "Materials Specifications."
9. State of California, Department of Transportation, Division of Highways, "Standard Specifications."
10. ~~State of California, Office of State Fire Marshal~~ Covered by Title 19 and Part 9
11. California Industrial Accident Commission, Safety Bulletins.
~~12. Uniform Building Code~~
~~13. Uniform Mechanical Code~~
~~14. Uniform Plumbing Code~~
15. Standard Specifications for Public Works, (Greenbook), with local agency amendments.

D. 2010 ADA Accessibility Standards for Accessible Design

1.3 REGULATORY NOTIFICATIONS

A. Submit all required notifications to Federal, State of California, State in which disposal facility is located if not in California, regional, and local agencies with regulatory responsibilities associated with the Work activities that are included in the Contract. All notifications shall be served in writing, in the form required by the agency requiring notification, and in a timely

manner so as not to negatively impact the Project schedule. Serve notifications at least 10 business days in advance (or earlier if required by agency) of activity requiring notice. The Contractor shall serve all required notifications in writing to all governmental and quasi-government agencies having notification requirements pertaining to any portion of the Work included in the Project.

B. Contractor shall file a Notice of Intent for coverage under State General Construction Activity Storm water Permit National Pollutant Discharge Eliminate System (NPDES). Contractor shall comply with applicable permit requirements including the project Storm Water Pollution Prevention Plan.

1.4 PERMIT REQUIREMENTS, NOTIFICATIONS, AND CERTIFICATES

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

B. Underground Service Alert (USA) Notifications: Prior to commencing clearing, excavation and trenching, coordinate with Underground Service Alert of Southern California for field verification and marking of utilities within the limits of Project site. Contractor shall be responsible for outlining limits of excavation with white chalk paint prior to coordination with USA. Coordination shall require 2 business days advance notification prior to start of excavation work. Provide USA notification permit number to the University's Representative prior to starting site Work.

C. In no event, shall the Contractor install materials that contain asbestos, PCB, lead or other known hazardous materials unless prior approval is obtained from the University.

D. Regulated Carcinogens by Title 8 California Code of Regulations (CCR), Subchapter 7, Group 16 (Control of Hazardous Substances), Article 110 (Regulated Carcinogens).
   1. Products containing chemicals regulated as carcinogens by the State of California are not allowed for use on University projects.
   2. Case-by-case exceptions may be considered for products containing the following Cal/OSHA recognized carcinogens:

      Methylene Chloride, 5202
      Cadmium, 1532, 5207
      Inorganic Arsenic, 5214
      Formaldehyde, 5217
      Benzene, 5218

   3. Case-by-case exceptions may only be made when suitable alternative products are not available. Such exceptions are subject to written approval by the University's Representative.
   4. Exceptions require that the Contractor shall have an established carcinogen program as required by Cal/OSHA (§5203. Carcinogen Report of Use Requirements) and shall submit to University's Representative, a copy of the Cal/OSHA Confirmation of Report for Cal/OSHA carcinogens.
   5. When exceptions are granted, the Contractor is responsible for providing to the University's Representative a copy of the semi-annual Confirmation of Report received from Cal/OSHA or, in lieu of that, a copy of the Contractor's semi-annual report as submitted to Cal/OSHA at periods not to exceed 6 months, or at project closeout, whichever occurs first.

E. Fire Department and Additional Notifications, Manifests, and Requirements: As required by University and coordinated by Contractor with the University's Representative.

1.5 FEES – NOT USED

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 41 40
WIND AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section is intended to be used for all aspects of this project. When there are conflicts between this Section and other wind and seismic design criteria given in the Contract Documents, the more stringent loading shall control unless clarified in writing during the Bid phase. Obtain clarification of all conflicts in writing prior to construction.

B. Section Includes:
   1. The wind and seismic design criteria for this project including all items directly specified in the Contract Documents as well as all items that are specified to be designed by the Contractor and submitted for approval.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
      b.
   2. American Institute of Steel Construction (AISC):
      a. 341, Seismic Provisions for Structural Steel Buildings.
      b. 360, Specification for Structural Steel Buildings.
   3. American Society of Civil Engineers (ASCE):
      a. 7-05, Minimum Design Loads for Buildings and Other Structures.
   4. Building code:
      a. International Code Council (ICC):
         1) California Building Code and associated standards, 2016 Edition including all amendments, referred to herein as Building Code.
   5. When referenced standards conflict the most stringent shall apply unless specifically indicated otherwise in the Contract Documents or unless approved otherwise in writing by the Engineer.

B. Qualifications:
   1. Engineer for Contractor designed items: Professional Engineer licensed in the State of California.

1.3 GENERAL DESIGN CRITERIA

A. This paragraph is applicable to both wind and seismic design criteria.

B. Design in accordance with the requirements of the Building Code and all applicable referenced standards.

C. Risk Category: II

D. Design in accordance with the Building Code load combinations for service level or factored level at Contractor's option.
   1. Mechanical and electrical equipment loads will be considered dead loads.

1.4 SEISMIC DESIGN CRITERIA

A. Seismic Design Load Criteria:
   1. Design spectral acceleration at short period: S_{DS} = 1.0.
   2. Design spectral acceleration at 1-second period: S_{D1} = 0.613.
   3. Importance Factor: Ie = 1.0

4. Component amplification factor, a_P: In accordance with ASCE 7-10, Tables 13.5-1 and 13.6-1.
5. Component response modification factor, R_P: In accordance with ASCE 7-10, Tables 13.5-1 and 13.6-1.
6. Component importance factor:
   a. $I_P = 1.00$.
   b. Fire and Life Safety components: $I_P = 1.50$.
7. Seismic Design Category: D.
8. Site Class: D.

B. Seismic forces must be resisted by direct load transfer through fasteners to all seismic resisting elements. Do not use connections that use friction to transfer seismic forces.

1.5 WIND DESIGN CRITERIA

A. Wind design load criteria:
1. Basic wind speed: 125 MPH.
2. Exposure category: C.
3. Topographic factor: $K_{zt} = 1.0$.
4. Wind importance factor: $I_w = 1.00$.
5. Internal Pressure Coefficient: GCpi = ±0.18.

B. Wind forces must be resisted by direct load transfer through fasteners to wind resisting elements. Do not use connections that use friction to transfer wind forces.

1.6 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Fabrication and/or layout drawings.
4. Certifications.
5. Test reports.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Structural Calculations:
   a. Submit calculations for each Contractor designed item under the Specification Section number for that item.
   b. Indicate compliance with specific referenced documents of the Building Code.
   c. Provide basis of design and lateral analysis as required to derive all loads and to show system stability including compatibility of deflections and compatibility with allowable soil parameters as applicable.
   d. Indicate design load to each connection.
   e. Provide a complete lateral load resisting system that transfers all wind and seismic loads through a load path to ground.
   f. Sealed by a professional engineer licensed in the State of California.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 42 00
REFERENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Specification Format and Content Explanation
2. Definitions
3. Reference Standards
4. Abbreviations and Acronyms

1.2 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on the 49-division format and CSI/CSC's "Master Format" numbering system.

B. Specification Content: These Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.
   a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon is used within a sentence or phrase.

1.3 DEFINITIONS

A. "Indicated": The term "indicated refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," "detailed" and "specified" are used to help the user locate the reference. Location is not limited.

B. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the University's Representative or University, requested by the University's Representative or University, and similar phrases.

C. "Approved": The term "approved," when used in conjunction with the University Representative's action on the Contractor's submittals, applications, and requests, is limited to the University Representative's duties and responsibilities as stated in the Conditions of the Contract.

D. "Regulations," "building code," "code": The terms "regulations," "building code", and "code" include laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

E. "Furnish": The term "furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

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

G. "Provide": The term "provide" means to furnish and install, complete in place, operating, tested, approved, and ready for the intended use.

H. "Installer": An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.
1. Unless specified otherwise in other Sections, the term "experienced," when used with the term "installer," means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction.
2. Trades: Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

I. "Project site" is the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

J. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

K. "Similar": The term "similar" means in the general sense and not necessarily identical.

L. See also the Instructions to Bidders and General Conditions.

1.4 REFERENCE STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
1. Requirements for packaging, packing, marking, and preparation for shipment or delivery included in referenced federal specifications are not mandatory for products provided for this Work.

B. Publication Dates: Comply with the standards in effect as of the date of the Contract Documents except where a specific publication date or issue is included with the reference in other Sections of these Specifications.
1. When a named or proposed product complies with a referenced standard of different publication date or issue than required by these Specifications, submit the product as a substitute under provisions of Division 01 Section "Substitutes." Provide a detailed written summary of changes in product or workmanship quality and performance as a result of the product complying with a different version of a standard from the version referenced.

C. 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, comply with the most stringent requirement. Refer uncertainties and requirements that are different but apparently equal to the University's Representative for a decision before proceeding.
1. 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, indicate numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to the University's Representative for a decision before proceeding.

2. Where a product is specified by both brand name and reference to 1 or more standards, provide that product only if it actually complies with the required standards. Listing of a product by brand or trade name in these Specifications is not a warranty that the product complies with the standards which may also be listed. If a named product does not comply with 1 or more of the required standards and no alternative product is listed which does comply, submit a substitute product under provisions of Division 01 Section "Substitutes" which complies with the required standards.

D. Copies of Standards: Each entity engaged in construction on the Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. 1. Where copies of standards are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source and make them available on request.

1.5 ABBREVIATIONS AND ACRONYMS

A. Trade Abbreviations and Association Names: Trade association names and titles of general standards are frequently abbreviated. The following abbreviations and acronyms, as referenced in the Contract Documents, mean the associated names. Names and addresses are subject to change and are believed, but not assured, to be accurate and up-to-date as the date of the Contract Documents.

B. Federal Government Agencies: Names and titles of Federal Government standards- or specification-producing agencies are often abbreviated. The following abbreviations and acronyms referenced in the Contract Documents indicate names of standards-or specification-producing agencies of the Federal Government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

C. The following are commonly used abbreviations which may appear in the Project Manual. Refer to Construction Specifications Institute Document TD-2-4 "Abbreviations" for explanation of other abbreviations.

C	degree Centigrade
Co.	Company
Corp.	Corporation
F	degree Fahrenheit
ft.	foot (feet)
ga.	gage or gauge
gal.	gallon(s)
in.	inch(es)
Inc.	Incorporated
HVAC	Heating, Ventilating and Air Conditioning
lb(s).	pound(s)
o.c.	on center
psi	pounds per square inch

psf	pounds per square foot
sq.	square
yd.	yard(s)

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 43 00
INSPECTION OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes, without limitation, the following:
   1. Access to the Work
   2. Testing and Approval
   3. University's Inspectors
   4. Inspection Requests
   5. Inspection Request Form
   6. Nonconforming Work Notice

B. The University will provide a Project Inspector or Inspector of Record (IOR) for this project. Contractor shall not cover any work requiring inspection until the IOR has inspected and approved the subject work. For uncovering of work, refer to General Conditions, Article 12.

1.2 ACCESS TO THE WORK

A. In addition to the requirements of the General Conditions, University, University's Representative and their representatives shall at all times have access to the Work wherever it is in preparation or progress and Contractor shall provide safe and proper facilities for such access and for inspection. The inspection and written acceptance of material and workmanship, unless otherwise stated in these Specifications, shall be final except as provided in Article 12.2 of the General Conditions.

1.3 TESTING AND APPROVAL

A. In addition to the requirements of the General Conditions, if any law, ordinance or public authority or the Specifications or University's Representative's instructions require any work to be specially tested or approved (including use of ionizing radiation for radiography), Contractor shall give University's Representative timely notice of its readiness for inspection, and if the inspection is by another authority, other than University's Representative, of the date fixed for such inspection.

B. Re-examination of questioned work may be ordered by University's Representative.

1.4 UNIVERSITY'S INSPECTORS

A. The IOR shall report to University's Representative. The IOR shall observe construction in progress and shall have the following responsibilities and limitations on authority.
   1. Act under the direction of University's Representative.
   2. Observe installation and work in progress as a basis for determining conformance of the work, materials and equipment with the Contract Documents. IOR will report any discrepancies observed to University's Representative and Contractor. Only University's Representative has the final authority to make approvals or rejections.
   3. Only University's Representative shall interpret the requirements of the Contract Documents. If any item is ambiguous, University's Representative shall make a written interpretation. If Contractor requests changes or modifications to the Contract Documents, University's Representative shall make a written determination on the requested changes or modifications.
   4. Prepare and submit an inspection report to University's Representative for each inspection performed.
   5. Review application for payments.

6. Assist University's Representative in reviewing the test and inspection results of testing laboratories.
7. The IOR is not authorized to permit deviations from the requirements of the Contract Documents unless such deviation has been approved by University's Representative in writing.
8. The IOR shall not supervise, coordinate, or direct the Work. The IOR has no responsibility or control over Contractor's construction means, methods, techniques, sequences, procedures, or coordination of any portions of the Work, or over any safety programs in connection with the Project.

B. The failure of University, University's Representative and its representatives and consultants, or University's IOR to observe or inspect the Work, or to detect deficiencies in the Work, or to inform Contractor of any deficiencies which may be discovered, shall not relieve Contractor, its subcontractors regardless of tier, or suppliers from their responsibility for construction means, methods, techniques, sequences and procedures, construction safety, nor from their responsibilities to carry out the work in accordance with the Contract Documents and to detect and correct defective work as defined in the General Conditions.

1.5 INSPECTION REQUESTS

A. Contractor shall request inspection of completed portions of the Work through University's Representative. Contractor shall submit a request for inspection using University's Inspection Request Form attached to the end of this Section.
1. Contractor shall submit an Inspection Request **at least 3 working days prior** to the time the work will be ready for inspection.
2. For work to be inspected by a third party testing laboratory, whether Contractor's or University's, Contractor shall submit an Inspection Request **at least 3 working days prior** to the time the work will be ready for inspection.
3. For work not in conformance with the Contract Documents, the IOR shall submit to the Contractor a Nonconforming Work Notice.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 Refer to the Inspection Request Form attached at the end of this Section.

3.2 Refer to the Nonconforming Work Notice Form attached at the end of this Section.

END OF SECTION

NONCONFORMING WORK NOTICE NUMBER: _____
DATE: _____

TO: **FROM:**

SPEC. SEC. REF.:_____ PARA:_____ DWG REF:_____ DETAIL:_____

DESCRIPTION OF DEFECTIVE CONDITION (IOR):_____

_____

_____

_____

_____

_____

REPORTED BY (IOR): _____

CORRECTIVE ACTION SHOULD BE TAKEN AS SOON AS POSSIBLE AND COORDINATED WITH THE INSPECTOR OF RECORD (IOR). IF FURTHER INFORMATION IS NEEDED, ADVISE THE UNIVERSITY'S REPRESENTATIVE IMMEDIATELY.

DESCRIPTION OF CORRECTIVE ACTION TAKEN (CONTRACTOR): _____

_____

_____

_____

_____

_____

ACCEPTED BY (CONTRACTOR):_____**DATE:**_____

UCR USE ONLY

ACCEPTANCE OF CORRECTED DEFECTIVE CONDITION (IOR):_____

_____

_____

_____

_____

_____

ACCEPTED BY (IOR):_____ **DATE:**_____

COPIES: ☐ UNIVERSITY ☐ CONSULTANT ☐ CONTRACTOR

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INTENTIONALLY

INSPECTION REQUEST
NUMBER: _____
DATE: _____

TO: _____ **FROM: _____**

DWG: _____ **REF: _____** **DETAIL: _____** **SHOP DWG: _____**

PROJECT SCHEDULE ACTIVITY ID NO. _____
DATE OF REQUESTED INSPECTION: _____ **TIME REQUESTED: _____**
TYPE OF REQUESTED INSPECTION: _____
SPECIFIC LOCATION OF REQUESTED INSPECTION (I.E. FLOOR AND/OR COLUMN LINE, ETC.):
_____

ALL WORK INCLUDED IN THIS **REQUEST FOR INSPECTION** HAS BEEN REVIEWED BY THE CONTRACTOR'S SUPERINTENDENT AND THE CONTRACTORS QUALITY CONTROL MANAGER FOR READINESS AND FOR COMPLIANCE WITH ALL OF THE CONTRACT DOCUMENTS. THIS HAS BEEN DONE PRIOR TO THE INSPECTION BEING REQUESTED.

SIGNED (CONTRACTOR) _____ **DATE: _____**

UCR USE ONLY

DATE REQUEST RECEIVED: _____
DATE OF ACTUAL INSPECTION: _____ **TIME OF ACTUAL INSPECTION: _____**
SCHEDULING INSPECTOR: _____ **INSPECTOR REPORT ATTACHED: ☐**

COMMENTS
INSPECTION RESULTS/DISPOSITION: _____

INSPECTOR SIGNATURE: _____ **DATE: _____**

***REQUIRED- ALL "AS-BUILT" PLANS ARE UPDATED AND MAINTAINED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND PROJECT ACTIVITY ☐ INSPECTOR: _____ DATE: _____**

COPIES: UNIVERSITY ☐ CONSULTANTS ☐ _____ ☐ _____ ☐ File

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INTENTIONALLY

SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for quality-control services, without limitation, the following:
   1. Contractor's Responsibilities
   2. Tests and Inspections
   3. Test Reports
   4. Geotechnical Engineer and Other Inspection and Testing – Not Used
   5. Repair and Protection

B. Quality-control services include inspections, tests, and related actions, including reports performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by University's Representative.

C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.

D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
   1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified inspections, tests, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with Contract Document requirements.
   3. Requirements for Contractor to provide quality-control services, required by University's Representative, are not limited by provisions of this Section.

E. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 01 Section "Cutting and Patching" specifies requirements for repair and restoration of construction disturbed by inspection and testing activities.

1.2 DEFINITIONS

A. The term "University's Testing Laboratory" means a testing laboratory retained and paid for by the University for the purpose of performing the testing services required by the Contract Documents except where specifically noted to be done by contractor, reviewing material and product reports, and performing other services as determined by University's Representative.

B. The term "Contractor's Testing Laboratory" means a testing laboratory retained and paid for by Contractor to perform the testing services which are required by the Contract Documents to be performed by Contractor. Contractor's Testing Laboratory shall be an organization other than University's Testing Laboratory and shall be acceptable to University's Representative. It may be a commercial testing organization or the testing laboratory of a trade association. Contractor's Testing Laboratory shall have performed testing of the type specified for at least five (5) years and shall maintain a separate General and Professional Liability Insurance, (Errors and Omissions,) in amount not less than one million dollars ($1,000,000) each.

C. Tests, inspections, and acceptances of portions of the Work required by the Contract Documents or by Applicable Code Requirements shall be made at the appropriate times. Contractor shall give University's Representative timely notice of when and where tests and inspections are to be

made and/or required regardless whose Testing Laboratory will perform the tests and inspections.

D. If such procedures for testing, inspection, or acceptance reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for University's Representative's services and expenses.

E. If University's Representative is to observe tests, inspections, or make acceptances required by the Contract Documents, University's Representative will do so promptly upon 3 days advance written notice and, where practicable, at the normal place of testing.

F. Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

1.3 CONTRACTOR'S RESPONSIBILITIES

A. Secure and deliver to Contractor's Testing Laboratory adequate quantities of representative samples of materials proposed for use as specified.

B. Submit to University's Testing Laboratory the preliminary design mixes proposed to be used for concrete and other materials which require review by University's Testing Laboratory.

C. Submit copies of product test reports as specified.

D. Furnish incidental labor and facilities, as required:
1. To provide University's Testing Laboratory access to the Work to be tested.
2. To obtain and handle samples at the Project site or at the source of the product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

E. Provide written notice to University's Representative sufficiently in advance (a minimum of 3 days) of operations to allow for University's Testing Laboratory assignment of personnel and scheduling of tests.

F. When tests or inspections are not performed after such notice, Contractor shall reimburse University for University's Testing Laboratory personnel and travel expenses incurred.

1.4 TESTS AND INSPECTIONS

A. Certain portions of the Work will be tested, inspected, or both, at various stages. Nothing in any prior acceptance or satisfactory test result shall govern, if at any subsequent time the Work, or portion thereof, is found not to conform to the requirements of the Contract Documents.

B. If initial tests or inspections made by University's Testing Laboratory's Geotechnical Engineer reveal that any portion of the Work does not comply with Contract Documents, or if University's Representative determines that any portion of the Work requires additional testing or inspection, additional tests and inspections shall be made as directed.

C. If such additional tests or inspections establish that such portion of the Work fails to comply with the Contract Documents, all costs of such additional tests and inspections, and all other costs resulting from such failure, including compensation for University's Representative and University Representative's Consultants shall be deducted from the Contract Sum.

D. Fixtures, equipment, materials, and other items removed, demolished, abandoned, or capped and left in place, shall be tested to verify that there is no damage caused after the items have been covered by construction.

1.5 TEST REPORTS

A. University's Testing Laboratory and Contractor's Testing Laboratory shall submit five (5) copies of all reports to University's Representative, indicating observations and results of tests and indicating compliance or non-compliance with the Contract Documents.

1.6 GEOTECHNICAL ENGINEER AND OTHER INSPECTION AND TESTING – NOT USED

A. The University shall retain and pay the expenses of a Geotechnical Engineer and materials testing, inspection and observation services consultant ("TIO Consultant") to perform inspection, testing, and observation functions specified by the University. Geotechnical Engineer and such other TIO Consultant shall communicate only with University and University's Representative. University's Representative shall then give notice to Contractor, with a copy to the University, of any action required of Contractor.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

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

B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.

C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION

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SECTION 01 45 16
CONTRACTOR'S QUALITY CONTROL PROGRAM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section includes, without limitation, the following:
   1. Quality Control Program
   2. Submittals
   3. Qualifications of Quality Control Manager
   4. Reporting Procedures
   5. Implementation

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

1.2 SUMMARY

A. This Section describes the requirements for implementation of a Quality Control Program by the Contractor to assure performance of the Work in conformance with the provisions of the Contract Documents.

B. Related Work Specified Elsewhere:
   1. Testing and Inspection Services of Quality Control are specified in Section 01 4500, "Quality Control."

1.3 QUALITY CONTROL PROGRAM

A. The Contractor shall prepare and submit within thirty (30) days after the issuance of Notice to Proceed, the Quality Control Program (QCP) they intend to implement for the Work for approval by the University. This Program shall be tailored to the specific requirements of the Work and shall become an active part of the construction procedures. The Quality Control Program shall include the procedures, instructions, reports and forms to be used throughout the performance of the Work. The University reserves the right to review and reject all or part of the Quality Control Program as proposed by the Contractor. The Contractor shall revise and resubmit as appropriate until satisfactory to the University. The basic objectives of the Quality Control Program are as follows:
   1. To ensure that all Work adheres strictly to all provisions of the Contract Documents and governing agencies.
   2. To produce good quality workmanship.
   3. To prevent deficiencies through pre-construction quality control coordination.
   4. To detect and correct deficiencies in a timely manner.
   5. To provide an auditable record of all tests, inspections, procedures, non-compliance and corrections, and any other pertinent data as required by the University.

B. The Contractor shall notify the University in writing of any proposed change to their Quality Control system and changes shall not be permitted if they would, in the opinion of the University, result in nonconformance with the Contract requirements.

C. The Contractor may select either an outside "agency" or in-house personnel to administer the program. In either case, the Quality Control staff on-site shall be responsible only for Quality Control and the Quality Control Manager shall report directly to the Contractor's highest ranking Corporate Officer involved in the Work. Quality Control staff members shall interface with the University, its Inspectors and Consultants, as required and appropriate.

1.4 SUBMITTALS

A. The Quality Control Program submittal shall include, as a minimum, the following:
   1. The Quality Control organization chart, beginning with the Quality Control Manager, shall include Quality Control personnel as may be necessary to accomplish complete and adequate inspection of the Work.
   2. Names and qualifications of personnel and firms selected to implement the Quality Control Program on-site and off-site.
   3. Authority and responsibility of the Quality Control Staff.
   4. Methods of Quality Control inspection including subcontractor's work and describing name of qualified testing laboratory to be used, if applicable.
   5. Documents to be used to record inspections and tests, including those specified in the Contract.
   6. Formats for documentation and reports.
   7. Model agenda for Quality Control Meetings
   8. A letter signed by the Responsible Managing Officer of the Contractor's firm outlining the authority of the Quality Control Manager to include, among other things, the authority as described herein. Clerical personnel sufficient to accomplish timely submittal of Quality Control Reports and other required documentation shall be provided.

1.5 QUALIFICATION OF QUALITY CONTROL MANAGER

A. The minimum qualifications required of the Quality Control Manager are as follows:
   1. Has recent construction experience in projects of similar size and nature.
   2. Has ten (10) years' experience performing construction-related work on Type I or II buildings.

B. Responsibilities and Duties of the Quality Control Staff:
   1. The Quality Control Manager shall have the authority to stop work, reject work, order work removed, initiate remedial work, propose solutions, and reject material not in compliance with the Contract Documents.
   2. Responsibilities of the Quality Control Manager shall include, but are not limited to the following:
      a. Present on-site during all working hours and assigned "full time" to this Project. Contractor shall designate alternate individual(s) to assume responsibilities in the temporary absence of the Quality Control Manager or when overtime work is being performed.
      b. Have complete familiarity with the Drawings and Specifications.
      c. Establish and implement Quality Control Programs for the Contractor and with the various Subcontractors and monitor their conformance.
      d. Present samples and test panels to be used as standards of quality for review by the University and their Consultants.
      e. Inspect existing conditions prior to the start of new work segments.
      f. Perform in-progress and follow-up inspections on each work segment to ensure compliance with the Contract Documents. Accompany the University and their Consultants on such inspections.
      g. Coordinate required tests, inspections, and demonstrations with the University's IOR inspectors, consultants and any other authority having jurisdiction.
      h. Inspect all materials and equipment arriving at the job site to ensure conformance to the provisions of the Contract Documents. Prepare and submit to the University written reports as required by the Contract Documents.
      i. Identify, report and reject defective Work or Work not in conformance with the Contract Documents. Monitor the repair or reconstruction of rejected Work.
      j. Develop checklists to be used for the inspection of each Division of the Work.
      k. Retain specialists or outside firms for inspection of Work in areas where additional technical knowledge is required (mechanical, electrical, electronics, controls, communications, security, welding, structural, security hardware, etc.).

l. Schedule additional site visits where appropriate.
m. Verify and report that all materials and equipment manufactured off-site are in conformance with the Contract Documents.
n. Prior to the start of each Division, Section and/or major item of Work required by the Contract Documents, conduct a preconstruction Quality Control meeting with responsible field and office representative and the University and their Consultants. Provide the University and their Consultants minutes of these meetings within forty-eight (48) hours.
o. Work closely with the University to ensure optimum Quality Control. Attend Project meetings as required by the University.

1.6 REPORTING PROCEDURES

A. As a minimum, develop forms, logs and reporting procedures consisting of the following:
1. A Quality Control meeting shall be held at least monthly between the University, Consultants and the Quality Control Manager during which only Quality related topics will be reviewed.
2. A monthly written report published at month end providing an overview of Quality Control activities, problems found and/or solved, status of remedial work, anticipated problems and planned activities for the coming month, etc.
3. Deficiency reports: Plan of action by the Contractor for correcting any known contract deficiencies including delay in scheduled progress.
4. Weekly reports (including reports from Contractor and Subcontractors) to the University describing:
a. Equipment and material received.
b. Tests and inspections performed with submittal information.
c. Deficiencies noted and/or corrected.
d. Quality Control concerns and problems.
e. Record keeping (as required).

1.7 IMPLEMENTATION

A. The Contractor's Quality Control program shall be adequate to cover all operations, including both on-site and off-site and will be keyed to the proposed sequence of work and shall include as a minimum at least three (3) phases of inspection for all definable items or segments of work, as follows:
1. Preparatory inspection shall be performed prior to beginning any work on any definable segment of the Work and shall include a review of Contract requirements; verification that all materials and/or equipment have been tested, submitted, and accepted; verification that provisions have been made to provide required control testing; examination of the work area to ascertain that all preliminary work has been completed; and a physical examination of materials and equipment to assure that they conform to accepted shop drawings or submittal data and that all material and/or equipment are available. As a part of this preparatory work, Contractor's Quality Control organization will review and verify that all documents, including but not limited to; shop drawings, submittal data, method of Quality Control, product data sheets, test reports, affidavits, certification and manufacturer's instructions have been submitted and accepted by the University as required herein. Each submittal to the University shall bear the date and the signature of the Contractor's Quality Control Manager indicating that he has reviewed the submittal and certified it to be in compliance with Drawings and Specifications or showing the required changes.
2. Initial Inspection: To be performed as soon as a representative segment of the particular item of work has been accomplished and to include examination of the quality or workmanship and a review of control testing for compliance with Contract requirements, exclusion of defective or damaged materials, omissions, and dimensional requirements.
3. Follow-up Inspection: To be performed daily or as frequently as necessary to ensure continuing compliance with Contract requirements, including control testing, until completion.

4. The Contractor shall maintain daily current records with information as described above, in an appropriate format of all inspections and tests that the required inspection or tests have been performed. These records must cover both conforming and defective items and must include a statement that all supplies and materials, incorporated in the Work, are in full compliance with the terms of the Contract. Two legible copies must be furnished to the University. The report will cover all work performed or completed subsequent to the previous report.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

SECTION 01 45 20
CONCRETE MOISTURE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Administrative Requirements
2. Information Submittals
3. Quality Assurance
4. Field Conditions
5. Materials for Test Procedures
6. Preparation
7. Testing: Testing for moisture vapor emission at concrete floors scheduled to receive applied floor coverings. Testing required at:
   a. New concrete floor slabs on grade.
   b. New elevated concrete floors where floor coverings are to be installed.
   c. New wood flooring over concrete sub floor.
8. Installation Control Measures

1.2 ADMINISTRATIVE REQUIREMENTS

A. Submittal Procedures: In accordance with Section 01 3300, "Submittals."

1.3 INFORMATIONAL SUBMITTALS

A. Quality Control:
1. Qualifications of personnel or laboratory to perform testing.
2. Results of substrate moisture testing for each location and maximum allowable levels specified in respective Specification Sections for the intended floor finish.

1.4 QUALITY ASSURANCE

A. If areas of concrete are not within the floor covering manufacturer's maximum allowable emission rate and slab area fails the moisture test, do not proceed with installation and notify the University's Representative.

1.5 FIELD CONDITIONS

A. Ambient Conditions:
1. Area to be tested shall match that of the finished floor covering.
2. Doors, windows, and roofing shall be installed and the temperature of the building interior environment shall be controlled.
3. Interior temperature shall be 75 degrees F, plus or minus 10 degrees F (23.9 degrees C plus or minus 5.5 degrees C).
4. Relative humidity shall be 50 percent, plus or minus 10 percent.
5. Maintain the above conditions for 48 hours prior to and throughout the duration of the tests.

PART 2 - PRODUCTS

2.1 MATERIALS FOR TEST PROCEDURES

A. Acceptable MVER Tests:
1. Calcium chloride test kits shall be pre-packaged and of commercial consistency; American Moisture Test, Inc., Tustin, CA, or equal. Kit shall include sealed dish of anhydrous calcium chloride, a metering dome with gasket, and instructions.

2. Relative humidity (RH) probe that has been verified for accuracy within the past year.

B. Alkalinity Tests: Test kit by American Moisture Test, Inc., Tustin, CA, or equal pH meter.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean concrete surfaces of any residues resulting from pour of concrete which will affect the moisture vapor drive.

B. Plastic dome of test kit shall be sealed airtight to prevent ambient humidity from influencing the test results.

3.2 TESTING

A. Perform tests on concrete slabs to determine moisture vapor emission based on the Moisture Vapor Emission Rate (MVER) content in accordance with ASTM F1869 or F2170, and alkalinity in accordance with ASTM F710. No testing shall be performed during non-acclimated periods. Results of these tests will be used to determine suitability of substrate to receive flooring materials. Perform two sets of tests, at 60 days and again at 14 days before the start of flooring installation.

B. Test Kit: Comply with ASTM F1869 and the following.
1. Verify temperature of slab is up to service temperature.
2. Duration of MVER test shall be 60 to 72 hours.
3. Dish shall be measured one-hour before and one-hour after testing with weight calculated within 0.1 grams.

C. RH Probe: Comply with ASTM F2170 and the following.
1. Verify concrete slabs are up to service temperature at least 48 hours prior to testing.
2. Depth of probes shall be 40 percent on slabs drying from the top only and 20 percent for slabs drying from both sides.
3. Probe shall be allowed to acclimate and checked for drift less than 1 percent relative humidity over a 5 minute period.
4. Elapsed time for test shall be 72 hours.

D. Alkalinity Testing: Comply with ASTM F710 and the following.
1. Verify that concrete surfaces are clean and that curing and sealing compounds have been removed.
2. Place a 1 inch diameter amount of manufacturer's recommended liquid on concrete surface and allow to settle for 60 seconds.
3. Insert meter into liquid and allow to calculate results.

E. Unless otherwise approved in writing by University's Representative, tests shall be performed by an independent testing agency.

F. Number of test kits shall be determined by the square footage of each flooring material. Provide minimum of three test kits for the first 1,000 square feet (93 square meters), and one test kit per each additional 1,000 square feet (93 square meters), with consideration to separation of test areas. At slab on grade conditions test within 2 feet of toilet rough-in's to determine any piping penetration failures.

G. Where calcium chloride test results are satisfactory but there is reason to suspect that unacceptable moisture levels below the upper two centimeters of the concrete may still exist, a relative humidity probe shall be used to test the full depth of the slab.

3.3 INSTALLATION OF CONTROL MATERIALS

A. If areas of concrete are not within the floor covering manufacturer's maximum allowable emission rate and slab area fails the moisture test, comply with the requirements specified in Section 07 1605, “Water Vapor Emission Control System”.

END OF SECTION

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SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Installation
2. Temporary Electricity
3. Temporary Water
4. Temporary Lighting
5. Temporary Heating, Cooling, and Ventilating
6. Temporary Telecommunications
7. Temporary Hot Water
8. Temporary Plumbing

1.2 INSTALLATION

A. Use qualified personnel for installation of temporary utilities. Locate utilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify utilities as required.

B. Provide each utility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until utilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Utility Service Connection: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.
1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
3. Obtain easements to bring temporary utilities to the site where the University's easements cannot be used for that purpose.
4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the University or University's Representative. Neither the University nor University's Representative will accept cost or use charges as a basis of claims for Change Orders.

D. Submittals:
1. Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
2. Implementation and Termination Schedule: Within 15 days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.
3. Temporary Utilities: Prepare a schedule indicating dates for taking over the responsibility of the existing temporary utilities that the University already has in place from the first phase and termination of each temporary utility. At the earliest feasible time, when acceptable to the University, change over from use of temporary service to use of permanent service.
4. Temporary HVAC Plan: Submit coordination drawing and narrative that indicates the HVAC-control measures proposed for use, existing systems connections, proposed locations, and proposed time frame for their operation.

5. Temporary Plumbing Plan: Submit coordination drawing and narrative that indicates the Plumbing-control measures proposed for use, existing systems connections, proposed locations, and proposed time frame for their operation.

E. Quality Assurance:
1. Comply with industry standards and applicable laws and regulations of the University including, but not limited to, the following:
   a. Potentially hazardous materials.
   b. Health and safety regulations.
   c. Utility company regulations.
   d. Police, fire department, and rescue squad rules.
   e. Environmental protection regulations.
2. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
   a. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."
3. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.
4. Construction Facilities and general construction activities shall comply with the energy use guidelines in Title 24 of the California Administrative Code.

1.3 TEMPORARY ELECTRICITY

A. Temporary Electric Power Service: Electric power will be furnished by the University at cost of $0.087/KWH. Provide weatherproof, grounded electric power service and distributions system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
1. Contractor Responsibilities:
   a. The University is providing temporary power equipment for the Contractor's use at the management trailer compound. The equipment includes; power skid, meter, quad-plex wire, panel board and NEMA enclosure. Install project site electric power service with a meter at the point of connection designated by the University's Representative. Refer to the diagram for locating temporary power connections at the end of this Section.
   b. Maintain connections and extensions in a safe manner and utilize so as to not constitute a hazard to persons or property.
   c. Connections and extensions will be subject to OSHA regulatory requirements. Immediately remove or remedy connections and extensions that represent safety hazards or cause undue interruption of University's normal operations.

1.4 TEMPORARY WATER

A. Water Service: Water for use in construction, testing, and irrigation will be furnished by the University at a cost of $1.12/CCF (748 gallons).
1. Contractor Responsibilities:
   a. Provide meter and all connections and extensions required.
   b. Maintain connections and extensions in a safe manner and utilize so as to not constitute a hazard to persons or property.
   c. Connections and extensions will be subject to approval of the University. Immediately remove or remedy connections and extensions that represent safety hazards or cause undue interruption of University's normal operations.

1.5 TEMPORARY LIGHTING

A. Temporary Lighting: Provide temporary lighting with local switching as required to supplement existing lighting.

B. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.

1.6 TEMPORARY HEATING, COOLING, AND VENTILATING

A. Required HVAC:
   1. During construction the contractor shall at all times maintain HVAC utilities (air handling supply/return air, fan exhaust air, chilled water, heating water, steam, etc.) without interruption, within critical portions of the building and those areas not actively being constructed based upon the phased construction plan. Critical building areas include:
      a. Keen Hall.
      b. Metabolomics laboratories 2215 & 2215B.
   2. Should it be necessary to interrupt any HVAC service or utility, the contractor shall secure permission in writing from the University for such interruption at least seven days in advance.
   3. Any interruption shall be made with minimum amount of inconvenience to the University and any shut-down time shall have to be on a premium time basis and such time to be included in the contractor's bid.
   4. Contractor to arrange to provide and pay for temporary HVAC if required by project conditions. Coordinate with the University in regard to temporary HVAC equipment delivery and placement.

B. Temporary Construction Heat:
   1. Provide temporary heat required by construction activities. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
   2. Maintain temperature at less than 60 DEGF (16 DEGC) in permanently enclosed portions of the building and areas where finished Work has been installed.
   3. Heating Facilities: Except where the University's Representative authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel-oil heaters with individual space thermostatic control. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

1.7 TEMPORARY TELECOMMUNICATIONS

A. Contractors and the University’s Representative field trailer/office construction trailers are optional. However if used, temporary telephones and Data Services: Provide temporary telephone and data service at the existing Construction Trailer site throughout the construction period for all personnel engaged in construction activities as described below.
   1. Provide Communications Work Order(s) (e.g. voice add and/or data add) for service through UCR Computing & Communications (UCR C&C), Communications Services, contact Sheri Morgan at (951) 827-3979. Contractor is responsible for providing Network Electronics, Telephone Sets and all installation and monthly recurring service charges.
   2. Install separate telephone lines (phone numbers) for each temporary trailer/office and first aid station. At each telephone, post a list of important telephone numbers.
   3. Provide telephone lines and telephone sets for the following:
      a. Contractor's field trailer/office: Direct-line telephones (telephone lines and telephone sets) as required.
      b. University's Representative’s field trailer/office: Three (3) Direct-line digital telephones and three (3) telephone sets.
   4. Provide data connections for the following:

a. Contractor's field trailer/office: as required. NOTE: A signed and approved Memo of Understanding (MOU) between Contractor(s) and UCR C&C will be required for all data services that are to be provided to Contractor(s).

1.8 TEMPORARY HOT WATER

A. During construction the contractor shall at all times maintain Hot Water (domestic and industrial) utility without interruption, within critical portions of the building and those areas not actively being constructed based upon the phased construction plan. Critical building areas include:
   1. Keen Hall.
   2. Metabolomics laboratories 2215 & 2215B.

B. Should it be necessary to interrupt any Hot Water service or utility, the contractor shall secure permission in writing from the University for such interruption at least seven days in advance.

C. Any interruption shall be made with minimum amount of inconvenience to the University and any shut-down time shall have to be on a premium time basis and such time to be included in the contractor's bid.

D. Contractor to arrange to provide and pay for temporary Hot Water if required by project conditions. Coordinate with the University in regard to temporary Hot Water equipment delivery and placement.

1.9 TEMPORARY PLUMBING

A. During construction the contractor shall at all times maintain Plumbing utilities (domestic and industrial cold water, acid waste/sanitary sewer, natural gas, compressed air, vacuum, etc.) without interruption, within critical portions of the building and those areas not actively being constructed based upon the phased construction plan. Critical building areas include:
   1. Keen Hall.
   2. Metabolomics laboratories 2215 & 2215B.

B. Should it be necessary to interrupt any Plumbing service or utility, the contractor shall secure permission in writing from the University for such interruption at least seven days in advance.

C. Any interruption shall be made with minimum amount of inconvenience to the University and any shut-down time shall have to be on a premium time basis and such time to be included in the contractor's bid.

D. Contractor to arrange to provide and pay for temporary Plumbing if required by project conditions. Coordinate with the University in regard to temporary Plumbing equipment delivery and placement.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 52 00
CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Supervision and Security
2. Maintenance
3. Field Offices and Sheds
4. First Aid Facilities
5. Sanitary Facilities
6. Storage
7. Termination and Removal

1.2 SUPERVISION AND SECURITY

A. Staff Names: Within 15 days of commencement of construction operations, post a list of the Contractor's principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.
1. Post copies of the list in the Project meeting room, the temporary field office, and each temporary telephone.

B. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

C. Security:
1. Protection and security measures required by the University are considered minimum requirements. Provide additional measures as necessary and appropriate to the hazards of this Project. Employ all measures necessary to ensure the security of the Project site. Security measures provided by the University do not relieve the Contractor from responsibility for site security and protection of the work as required by the Contract Documents.
2. Watchman: The University will not be providing security services for the Project. During all hours that Work is not being prosecuted, including weekends and holidays, furnish such watchman's services as Contractor may consider necessary to safeguard materials and equipment in storage on the Project site, including Work in place or in process of fabrication, against theft, acts of malicious mischief, vandalism, and other losses or damages. The University will not be liable for any loss or damage.
3. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
a. Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

1.3 MAINTENANCE

A. Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities if required, as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

B. 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. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

1.4 FIELD OFFICES AND SHEDS

A. Locate field offices, storage sheds, and other temporary construction and support facilities for easy access, and as approved by the University's Representative, within the area of the site designated as "Limits of Work".

B. Field Offices: Contractor shall provide an insulated, weather tight, temporary office of sufficient size to accommodate the required office personnel at the Project Site with adequate lighting, power, heating, and cooling. Contractor to keep the office clean and orderly for use for progress meetings and shall be responsible for providing a cleaning/maintenance service to maintain and clean 2x a week for the duration of the project. Contractor shall provide an office or separate trailer with two desks and chairs for use by University personnel. University personnel shall have full use and access to a copier/scanner and access and use of bottled or filtered potable water, coffee maker and microwave.

C. Storage and Fabrication Sheds: Install storage and fabrication sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service.
   1. Maintain secure storage for tools (including personal tools of individual workers), equipment, and materials. The University will not be responsible for loss or damage to tools, equipment, or materials.

D. Equipment
   1. General: Provide new equipment. If acceptable to the University's Representative, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.
   2. Water Hoses: Provide ¾-inch (19-mm), heavy –duty, abrasion-resistant, flexible rubber hoses 100 feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.
   3. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
   4. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
   5. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.
   6. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
   7. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.
      a. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
      b. Comply with requirements of authorities having jurisdiction.

1.5 FIRST AID FACILITIES

A. First Aid Supplies: Provide types and quantities required by referenced standards, the University's Representative, and as prudent for the conditions existing for the Work.

1.6 SANITARY FACILITIES

A. University's existing sanitary facilities may be used only with the prior approval of University's Representative. Contractor shall maintain sanitary facilities in a clean and sanitary condition.

B. Do not flush construction materials down toilets or sinks.

C. Contractor is solely responsible for repairing damage to existing construction and finishes and for replacing damaged components, which cannot be repaired.

1.7 STORAGE

A. Contractor's use of the Project site for the Work and storage is restricted to the areas designated on the Drawings or as approved by University's Representative. Use of mechanical and electrical rooms for storage of materials or furniture is prohibited.

B. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
   1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
   5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
   6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
      a. Concrete slabs on grade and suspended floors have not been designed for heavy loading.
      b. Slabs on Grade: Do not subject slabs on grade to excessive loading by shoring, storage of materials, or operation of construction equipment unless adequately protected by planking designed to safely distribute loads. Maintain slabs and repair or replace damaged slabs at no additional cost to the University.
      c. Suspended Floors: Do not subject suspended slabs to construction loads greater than 40 psf unless adequate shoring and protection is provided. Retain a civil or structural engineer experienced in shoring design and registered in the State of California to design necessary temporary support systems.
   7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
   8. Immediately remove from the site materials and equipment that are damaged or do not comply with requirements of the Contract Documents.
   9. When handling and moving materials and equipment, protect all finished surfaces.

C. Keep copies of manufacturer's specifications and instructions on site and available for reference.

1.8 TERMINATION AND REMOVAL

A. Remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary

facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

B. Materials and facilities that constitute temporary facilities are the Contractor's property. The University reserves the right to take possession of project identification signs.

C. Repair or replace street paving, curbs, and sidewalks damaged by construction traffic.

D. At Substantial Completion, clean and renovate any permanent facilities used during the construction period.

E. After removal of temporary facilities at the management compound in Lot 14 i.e. office trailers, wood patio decks, ramps, fencing, anchorage, electrical equipment, etc. which were placed on portions of the existing site not scheduled for new Work, Contractor shall repair all damage, holes, etc., to the pavement and apply a seal coat to the pavement and restripe all of the stalls in the three rows of parking (approximately 42 spaces) adjacent to the management compound. A parking stall layout shall be provided by the University Representative.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 53 00
TEMPORARY CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Temporary Stairs, Scaffold, and Runways
2. Trenching and Shoring – Not Used
3. Temporary Bridges – Not Used
4. Temporary Decking – Not Used
5. Temporary Overpasses – Not Used
6. Temporary Ramps – Not Used
7. Temporary Runarounds – Not Used

1.2 TEMPORARY STAIRS, SCAFFOLD, AND RUNWAYS

A. Provide all scaffolds, stairs, hoist plant, runways, platforms, and similar temporary construction as may be necessary for the performance of the Contract. Such facilities shall be of the type and arrangement as required for their specific use, substantially constructed throughout and strongly supported, well secured and complying with all applicable rules and regulations of the Industrial Accident Commission of the State of California and all applicable laws and ordinances. Refer to Section 01 4100, Regulatory Requirements.

B. Arrange for construction equipment access to areas which may be partly blocked by existing obstructions.

1.3 TRENCHING AND SHORING – NOT USED

1.4 TEMPORARY BRIDGES – NOT USED

1.5 TEMPORARY DECKING – NOT USED

1.6 TEMPORARY OVERPASSES – NOT USED

1.7 TEMPORARY RAMPS – NOT USED

1.8 TEMPORARY RUNAROUNDS – NOT USED

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

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SECTION 01 54 00
CONSTRUCTION AIDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:
1. Temporary Elevators – Not Used
2. Temporary Lifts and Hoists
3. Temporary Cranes
4. Temporary Swing Staging – Not Used

1.2 TEMPORARY ELEVATORS – NOT USED

1.3 TEMPORARY LIFTS AND HOISTS

A. Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

1.4 TEMPORARY CRANES

A. Provide necessary cranes, rigging equipment and personnel

1.5 TEMPORARY SWING STAGING – NOT USED

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 01 55 00
VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Temporary Access Roads – Not Used
2. Haul Routes – Not Used
3. Temporary Parking Areas
4. Temporary Roads – Not Used
5. Traffic Control
6. Staging Areas

B. Submittals:
1. Submittals shall be submitted in accordance with Section 01 3300, "Submittals."
   a. Submit Traffic Control Plan for Project Construction prior to the start of construction activities for approval by University's Representative.
   b. Submit Pedestrian Access Plan for Project Construction prior to the start of construction activities for approval by University's Representative.

1.2 TEMPORARY ACCESS ROADS – NOT USED

1.3 HAUL ROUTES – NOT USED

1.4 TEMPORARY PARKING AREAS

A. Parking: Limited parking for workers employed on the Work may be provided on the Project Site to the extent that space for that purpose is available without interference with activities of University or activities related to performance of the Work. Refer to Section 01 3543 "Environmental Procedures".
1. All vehicles are required to display a parking permit while parked on campus. Transportation and Parking Services will sell parking permits to contractors, their employees and sub-contractors in parking lots where spaces are currently available for purchase. 2014-15 monthly permit rates are $44/Gold, $53.50/Blue and $73.50/Red. All rates are subject to change. Monthly permits are available at the Parking Service Building located at 683 Linden Street. Daily permits can be purchased in the Parking Service Building, at information kiosks at campus entrances, and in posted visitor parking lots. Parking permits are lot specific. All vehicles entering the campus are required to adhere to the University's parking policies and the California Vehicle Code. .
2. Contractor may use available space within its Project Site fence limits for parking without a permit.
3. Provide 3 parking spaces within Contractor's Project Site fence limits for University's Representative and its Consultants use.

1.5 TEMPORARY ROADS – NOT USED

1.6 TRAFFIC CONTROL

A. Prior to the start of construction activities, determine the routing of construction vehicles and the measures necessary to control traffic during construction. Provide measures including, but not limited to, the following:
1. Contractor is responsible for controlling construction traffic on and adjacent to the site, including public right-of-ways. Comply with requirements of authorities having jurisdiction for traffic controls in public right-of-ways.

a. Provide necessary measures including, but not limited to, flag personnel, barricades, sufficient lights, reflectors, warning signals, warning signs indicating closures, directional, and detour instructions.

2. Route construction equipment, trucks, and similar vehicles through the campus to Big Springs Road and existing public streets to and from the site as approved by the University's Representative and as specified in Section 01 3543 Environmental Procedures.
3. Schedule deliveries to minimize disruption of University traffic and duration of on-site storage.

B. Traffic Control Plan for Project Construction.
1. Contractor and all subcontractors shall ensure that the construction site and access road speed limits are established and enforced during the Contract Time until Substantial Completion. Post and enforce traffic speed limits of 15 miles per hour or less on all unpaved roads.
2. Contractor and all subcontractors shall comply with the Traffic Control Plan for project construction prepared by Contractor and approved by University's Representative prior to the commencement of construction activities.
3. To the extent reasonable, Contractor and all subcontractors shall maintain at least one unobstructed lane in both directions on campus roadways. At any time only a single lane is available, Contractor and all subcontractors shall provide a temporary traffic signal, signal carriers (i.e., flag persons), or other appropriate traffic controls, as approved by University's Representative, to allow travel in both directions. If construction activities require the complete closure of a roadway segment, contractor and all subcontractors shall provide appropriate signage indicating alternative routes as approved by University's Representative.
4. To maintain adequate access for emergency vehicles when construction activities would result in roadway closures, Contractor shall give 14-days notice to the University's Representative, so that the University's Representative can consult with the UCPD, EH&S, and Riverside Fire Dept. as appropriate to disclose closures and identify alternative travel routes.
5. The hauling and disposal of any excess clean soil excavated from or already stockpiled on the site will be the responsibility of the contractor to transport and stockpile it at the UCR Ag Ops area located near Lot 13 as directed by the University Representative.
6. All construction traffic will access the Project Site from the west and through the campus. Construction traffic will avoid using Valencia Hill Drive, Watkins Drive and Big Springs Road. There are two existing, posted construction traffic warning signs at the corner of Watkins Drive and Valencia Hill Drive which shall remain in place and maintained by the Contractor for the duration of the Project and will be the Contractor's responsibility to remove and dispose of the signs at the completion of the Work.

C. Pedestrian Access Plan for Project Construction.
1. Contractor and all subcontractors shall comply with the Pedestrian Access Plan for project construction prepared by the Contractor and approved by University's Representative, prior to the commencement of construction activities.

1.7 STAGING AREAS

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 56 00
TEMPORARY BARRIERS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
1. General Cleaning and Protection
2. Temporary Fire Protection
3. Temporary Barricades, Warning Signs, Signals and Lights
4. Temporary Fencing
5. Temporary Protective Walkways – Not Used

1.2 GENERAL CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:
1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Air contamination or pollution.
7. Water or ice.
8. Solvents.
9. Chemicals.
10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining, and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.

29. Theft.
30. Vandalism.

1.3 TEMPORARY FIRE PROTECTION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the University's Representative.

B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers,"NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," and requirements of the University.
   1. Locate fire extinguishers where convenient and effective for their intended purpose.
   2. Store combustible materials in containers in fire-safe locations.
   3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in all buildings and anywhere on site.
   4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

1.4 TEMPORARY BARRICADES, WARNING SIGNS, SIGNALS AND LIGHTS

A. Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
   1. Enclose excavations and openings with proper barricades.
   2. Clearly identify hazards on and adjacent to the Project site. Maintain clearly visible and, if applicable, audible identification on a continuous 24-hour-per-day basis.
   3. Illuminate barricades, warning signs, obstructions, and other hazards at night. Provide adequate light for clear visibility from sunset to sunrise.
   4. Where appropriate, provide audible warning signals.

1.5 TEMPORARY FENCING

A. As needed, it will be the Contractors responsibility to furnish, design, have installed, maintain, and include all costs included in bid. **Temporary fencing and gate opening plan shall be submitted to the University's Representative and Campus Fire Marshal for approval within 5 days from the Notice to Proceed.**

1.6 TEMPORARY PROTECTIVE WALKWAYS – NOT USED

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

SECTION 01 57 00
TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:
1. Control of Construction Water
2. Dust Control, Air Pollution, and Odor Control
3. Noise Control
4. Temporary Erosion and Sediment Control (SWPPP)
5. Temporary Environmental Controls
6. Temporary Pest Control – Not Used
7. Biological Resources – Not Used
8. Cultural Resources – Not Used
9. Aesthetics – Not Used
10. Air Quality

1.2 CONTROL OF CONSTRUCTION WATER

A. Provide impermeable floor coverings and suitable dams to prevent damage by water used for the Work. Immediately clean up and remove all surplus water and water spilled in non-working areas. Do not allow water to overflow gutters, flood streets or parking lots.

1.3 DUST CONTROL, AIR POLLUTION, AND ODOR CONTROL

A. The Contractor shall employ measures to prevent the creation of dust, air pollution and odors.
1. Unpaved areas where vehicles are operated shall be periodically wetted down or given an equivalent form of treatment as defined in South Coast Air Quality Management District (SCAQMD) Rule 403 to eliminate dust formation.
2. All volatile liquids including fuels or solvents shall be stored in closed containers.
3. No open burning of debris, lumber or other scrap will be permitted.
4. Equipment shall be maintained in a manner to reduce gaseous emission.
5. Low sulfur fuel shall be used for construction equipment.
6. Stockpiles of excavated materials shall be covered with material approved by University's Representative.
7. Contractor shall provide street sweeping whenever silt from construction site is carried over to adjacent streets.

B. Provide measures, including regular watering, necessary to minimize air-borne dust.
1. Exposed surfaces should be watered twice daily.
2. Stockpiles of excavated materials should be covered.
3. A berm shall be erected on the downslope of the project site to prevent silt-laden water from running off site.
4. Trucks carrying excavated materials from the site shall be covered and shall have their tires and undercarriages washed prior to exiting the site as required to remove material that may fall or blow off later.
5. Paving of exposed dirt surfaces should be done as quickly as is reasonably possible.
6. Streets affected by fugitive dust shall be swept regularly.
7. The Contractor shall assign a person to be responsible for monitoring dust levels, reviewing conditions with the University's Representative, and suggesting appropriate additional control measures when required.
8. Uncovered soil shall be bound by grass or similar ground cover as soon as is reasonably possible.
9. Excavation should not be conducted when surface winds exceed 11 miles per hour.

10. Unnecessary idling of construction vehicles and equipment shall be avoided.

C. All contractors, and overseen by the General Contractor, shall implement dust control measures consistent with South Coast Air management District (SCAQMD) Rule 403 – Fugitive Dust during the construction phases on the project development.
   1. Apply water and/or non-toxic chemical soil stabilizers according to manufacturer's specifications to all inactive construction areas (previously graded areas that have been inactive for 10 or more days).
   2. Replace ground cover in disturbed areas as quickly as possible.
   3. Enclose, cover, water twice daily, or apply approved chemical soil binders to exposed piles with 5 percent or greater silt content.
   4. Water active grading sites at least twice daily.
   5. Suspend all excavating and grading operations when wind speeds (as instantaneous gusts) exceed over 25 mile per hour over a 30-minute period.
   6. All trucks hauling dirt, sand, soil, or other loose material are to be covered or should maintain at least two feet of freeboard (i.e., minimum vertical distance between top of the load and top of the trailer) in accordance with section 23114 of the California Vehicle Code.
   7. Sweep streets at the end of the day if visible soil material is carried over to adjacent roads.
   8. Install wheel washers where vehicles enter and exit unpaved roads onto paved roads, or wash off trucks and any equipment leaving project site for each trip.
   9. Apply water three times daily of chemical soil stabilizers according to manufacturer's specifications to all unpaved parking or staging areas or unpaved road surfaces.

1.4 NOISE CONTROL

A. Noise control shall be maintained by the contractor in all areas of construction, guarding against any undue noise which may impair proper use of existing facilities. Activities with the highest noise potential shall be scheduled for the times when background ambient noise levels are highest (i.e., during peak commute hours). Contractor shall use noise suppressed equipment available and/or shall muffle/control noise on equipment to the maximum extent possible. Noisy construction-related operations (e.g. mixing concrete) shall be accomplished on-site to the extent feasible. Those noisy, construction-related operations shall be performed on those areas of the site furthest from noise sensitive receptors i.e. residence halls, off-site community, etc."

   OR

   Noise control shall be maintained by the contractor in all areas of construction, guarding against any undue noise, which may impair proper use of existing facilities. Contractor shall use noise suppressed equipment available and control noise on equipment to the maximum extent possible.

B. The following noise control procedures shall be employed:
   1. Maximum Noise: The Contractor shall use equipment and methods during the course of this work that are least disruptive to adjacent offices or residences. Noise levels for trenchers, graders, trucks and pile drivers shall not exceed 90 dBA at 50 feet as measured under the noisiest operating conditions. For all other equipment, noise levels shall not exceed 85 dBA at 50 feet.

      OR

      Noise control shall be maintained by the contractor in all areas of construction, guarding against any undue noise, which may impair proper use of existing facilities. Contractor shall use noise suppressed equipment available and control noise on equipment to the maximum extent possible.
   2. Equipment: Jack hammers shall be equipped with exhaust mufflers and steel muffling sleeves. All diesel equipment shall have exhaust muffled. Air compressors shall be of a quiet type such as a "whisperized" compressor.

      OR

Equipment: Jack hammers shall be equipped with exhaust mufflers and steel muffling sleeves. All diesel equipment shall have exhaust muffled. Air compressors shall be of a quiet type such as a "whisperized" compressor. Require contractors to use the quietest among alternative equipment or to muffle/control noise from available equipment to the maximum extent possible.

AND/OR

Require Mufflers and Other Noise Attenuators on Project Construction Equipment: All contractors, and overseen by the General Contractor, shall ensure that noise-producing construction equipment and vehicles using internal combustion engines will be equipped with mufflers; air-inlet silencers where appropriate; and any other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specification. Mobile or fixed “package” equipment (e.g., arc-welders, air compressors) will be equipped with shrouds and noise-control features that are readily available for that type of equipment. Stationary construction equipment, material and vehicle staging shall be placed to direct noise away from sensitive receptors.

AND OR

Require Use of Electrically Powered Equipment: All contractors, and overseen by the General Contractor, shall ensure that work use electrically powered equipment instead of pneumatic or internal combustion–powered equipment, where feasible.

3. Operations: Machines shall not be left idling. Electric power shall be used in lieu of internal combustion engine power wherever possible. Equipment shall be maintained to reduce noise from vibration, faulty mufflers, or other sources.

   OR

   Operations: Machines shall not be left idling. Electric power shall be used in lieu of internal combustion engine power wherever possible. Equipment shall be maintained to reduce noise from vibration, faulty mufflers, or other sources.
4. Scheduling: Noisy operations shall be scheduled so as to minimize the disturbance and duration to adjacent neighborhoods and nearby student Housing complexes.

   OR

   Scheduling: Noisy operations shall be scheduled so as to minimum their disturbance to occupied adjacent areas and duration at any given location. Schedule activities with highest noise potential for times when background ambient noise levels are highest.
5. Location: Consider noise sensitive areas around the site when planning locations of operations which cause higher levels of noise, and perform those tasks in less sensitive areas when possible. Schedule work that will generate vibrations, uncontrolled dust , noise levels in excess of 65 dBA, interior- 85 dBA, exterior and potentially hazardous conditions for time periods that are the least disruptive to the University and the surrounding residential neighborhood.
6. Use of High Vibration Construction Equipment near School of Medicine
   a. All contractors, and overseen by the General Contractor, shall schedule construction activity entailing use of high-vibration generating equipment within 75 feet of Residence Halls during periods when students are not in residence, to the extent feasible.
7. Prohibit Noise-producing Signals: All contractors, and overseen by the General Contractor, shall prohibit the use of noise-producing signals, including horns, whistles, alarms, and bells, except for safety purposes only. Public address or music systems will also be prohibited.

1.5 TEMPORARY EROSION AND SEDIMENT CONTROL

A. Exposed earth surfaces shall be watered to minimize dust generation as necessary according to weather conditions.

B. During winter construction, an erosion and sediment-transport control plan incorporating standard erosion control practices shall be implemented prior to the first day of earth moving activities.
   1. Erosion control shall include retaining sediments within project site by the use of catch basins; using interceptor ditches and benches to prevent gullying of slopes; and preparing and implementing erosion control plans.

C. Storm Water Pollution Prevention Plan (SWPPP):
   1. This project has an active SWPPP permit and the university has retained a SWPPP management consultant for this project. The contractor shall take over the contract of the SWPPP consultant for the SWPPP management of the project for the duration of the schedule until substantial completion. Contact David Beckwith, President, David Beckwith & Associates at (714) 349-7007. The details of the SWPPP for School of Medicine Clinical Skills and its implementation can be viewed online at the California State Water Resources Board's SMARTS website (type "University of California, Riverside").
   2. Protection Against Inclement Weather: Brace, secure, and cover all parts of the Work to prevent damage by inclement weather. Refer to Section 3.9 Storm Water Control for SWPPP information.
   3. Protect the Work from damage due to nuisance water such as rainwater, surface runoff, and irrigation water. Comply with requirements of the University's Representative regarding routing and disposal of nuisance water.

D. Storm Water Control
   1. This project already has an open SWPPP permit on file. Refer to Section 01 1400 "Contractor's Use of the Project Site" for more detailed SWPPP information.
      a. Provide engineering, drawings, etc., to meet the requirements.
   2. Erect berm and other appropriate measures to prevent water from running off site and staging area.
   3. Erect berm and other appropriate measures to prevent water from entering the site and staging area.
   4. Temporary Storm Water Pollution Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

1.6 TEMPORARY ENVIRONMENTAL CONTROLS

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce levels of harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.

B. See also Section 01 3543, Environmental Procedures.

1.7 TEMPORARY PEST CONTROL – NOT USED

1.8 BIOLOGICAL RESOURCES – NOT USED

1.9 CULTURAL RESOURCES – NOT USED

1.10 AESTHETICS – NOT USED

1.11 AIR QUALITY

A. All construction vehicles and equipment containing an internal combustion engine and operating on the project site shall meet EPA-certified Tier 2 emission standards or higher. Contractor shall maintain on-going verification records of equipment certification as new equipment is delivered to the site for University Representatives to review for compliance.
   1. Compliance with all SCAQMD rules and regulations.

2. Maintenance programs to assure vehicles remain in good operating condition.
3. Avoid unnecessary idling of construction vehicles and equipment.
4. Use of alternative fuel vehicles.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

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SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project:
   1. Quality Assurance
   2. Product Delivery, Storage, and Handling
   3. Product Selection
   4. Product Installation

B. Definitions: The Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
   1. “Products” are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
      a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature that is current as of the date of the Contract Documents.
      b. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
   2. “Materials” are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
   3. “Equipment” is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.2 QUALITY ASSURANCE

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
   1. Each prime contractor is responsible for providing products and construction methods that are compatible with products and construction methods of other prime or separate contractors.
   2. If a dispute arises between prime contractors over concurrently selectable, but incompatible products, the University's Representative will determine which products shall be retained and which are incompatible and must be replaced.

C. Foreign Product Limitations: Except under one or more of the following conditions, provide domestic products, not foreign products, for inclusion in the Work:
   1. No available domestic product complies with the Contract Documents.
   2. Domestic products that comply with the Contract Documents are available only at prices or terms substantially higher than foreign products that comply with the Contract Documents.

D. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturers' or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
   1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
      a. Name of product and manufacturer.
      b. Model and serial number.
      c. Capacity.
      d. Speed.
      e. Ratings.
   3. UL Label: Provide products bearing appropriate UL label as indicated.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 01 5200, Article 1.7.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation, except where salvaged materials are indicated.
   1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
   2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

B. Product Selection Procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:
   1. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
   2. Compliance with Standards, Codes, and Regulations: Where Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standards, codes, or regulations specified.
   3. Visual Matching: Where Specifications require matching an established Sample, the University Representative's decision will be final on whether a proposed product matches satisfactorily.
      a. Where no product available within the specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category.
   4. Visual Selection: Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The University's Representative will select the color, pattern, and texture from the product line selected.

PART 3 - EXECUTION

3.1 PRODUCT INSTALLATION

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
   1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 01630
PRODUCT OPTIONS AND SUBSTITUTIONS

1.1 General Provisions Regarding Specification Of Products, Material or Equipment By Brand Or Trade Name.

1.1.1 Products, material or equipment specified by both brand or trade name and model number are approved for use, provided that CM/Contractor complies with all Contract requirements. Specification of a product, material or equipment by brand or trade name and model number is not a representation or warranty that the product, material or equipment can be used without modification, to meet the requirements of the plans and specifications; CM/Contractor shall, at its sole cost, modify such products, material, or equipment so that they comply with all requirements of the plans and specifications.

1.1.2 The first-named product, material or equipment specified by brand or trade name and model number is the basis for the Project design and the use of any item other than the first-named one may require modifications of that design. If CM/Contractor uses any product, material or equipment other than the first-named one, CM/Contractor shall, at its sole cost:

.1 Make all revisions and modifications to the design and construction of the Work necessitated by the use the product, material or equipment.

.2 Be responsible for all costs of any changes resulting from the use of the product, material or equipment including without limitation, costs or changes which affect other parts of the Work, the work of Separate Contractors, or any other property or operations of the University.

1.1.3 When a product, material or equipment specified by brand or trade name is followed by the words “or equal,” a substitution may be permitted if the substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and if the substitution complies with all other requirements of the plans and specifications.

1.1.4 A product, material or equipment specified by brand or trade name followed by the words “or equal, no known equal,” signifies that University does not have sufficient knowledge to specify a product, material or equipment, other than the one specified by brand or trade name, that is suitable for use on the Project. The use of the words "no known equal" is not intended to discourage substitution requests in accordance with the requirements specified herein.

1.1.5 When catalog numbers and specific brands or trade names not followed by the designation "or equal" are used in conjunction with a product, material or equipment required by the specifications, substitutions will not be allowed and the named product, material or equipment must be used.

1.1.6 Specification of a product, material or equipment by brand or trade name and model number is not a representation or warranty that the product, material or equipment is available; CM/Contractor should confirm, prior to submitting its Bid, the availability of any product, material or equipment specified by brand or trade name and model number.

1.2. Special Requirements For Products, Material Or Equipment, Other Than The First-Named Product, Material Or Equipment, Specified By Both Brand Or Trade Name And Model Number.

1.2.1 In addition to complying with all other submittal requirements of the Contract, submit within 70 days after the date of commencement specified in the Notice to Proceed for Phase 1, for review and approval by the University's Representative, CM/Contractor prepared specifications and drawings, including design and engineering calculations, prepared by an appropriate licensed professional, depicting all revisions and modifications to the design and construction of the Work necessitated by the use of the product, material or equipment. If no revisions or modifications are necessary, submit within 70 days after the date of commencement specified in the Notice to Proceed for Phase 1, a written representation that no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment. CM/Contractor shall utilize the first-named product, material or equipment if CM/Contractor fails to make the appropriate required submittal pursuant to this paragraph within the 70-day period.

1.2.2 A product, material or equipment, other than the first-named product, material or equipment, specified by both brand or trade name and model number may be used if no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment. If such revisions or modifications are necessary, the product, material or equipment may be used only if the revisions or modifications are approved in writing by the University's Representative. CM/Contractor has the burden of demonstrating, through the procedures specified herein, that any such revisions or modifications will not be detrimental to the quality, utility or appearance of the Project or any portion of the Project. The University's Representative may refuse to approve any such proposed revisions or modifications where, in the reasonable opinion of the University's Representative, CM/Contractor has failed to demonstrate, through the procedures specified herein, that the revisions or modifications are not detrimental to the quality, utility or appearance of the Project or any portion of the Project.

1.3. Special Requirements For Substitutions.

1.3.1 In addition to complying with all other submittal requirements of the Contract, submit written data demonstrating that the proposed substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and otherwise complies with all requirements of the plans and specifications, including:

.1 Complete technical data including drawings, performance specifications, samples, and test reports of the article proposed for substitution.

.2 Statement by CM/Contractor that the proposed substitution is in full compliance with the requirements of the Contract Documents and Applicable Code Requirements.

.3 List of Subcontractors, if any, that may be affected by the substitution.

.4 CM/Contractor prepared specifications and drawings, including design and engineering calculations, prepared by an appropriately licensed professional, depicting all revisions and modifications to the design and construction of the Work necessitated by the use of the substitution. If no revisions or modifications are necessary, submit a written representation that no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment.

1.3.2 At the request of and within the timeframes specified by the University's Representative:

.1 Submit samples as deemed necessary by the University's Representative to evaluate the proposed substitution.

.2 Submit proposed substitution to tests deemed necessary by the University's Representative to evaluate the proposed substitution. Such tests shall be made by an independent Testing Laboratory and at the sole expense of CM/Contractor, after review and approval of the test procedures by University's Representative. If re-testing is deemed necessary by the University's Representative to evaluate the proposed substitution, such re-testing shall be made by an independent Testing Laboratory at the sole expense of the CM/Contractor.

.3 Provide any additional information deemed necessary by the University's Representative to evaluate the proposed substitution.

1.3.3 If University's Representative, in reviewing a proposed substitution, requires revisions or corrections to be made to previously accepted shop drawings and supplemental supporting data to be resubmitted, CM/Contractor shall do so within the time period specified by the University's Representative. A proposed substitution may be rejected if CM/Contractor fails to submit such revisions, corrections, or supplemental supporting data within the specified time period.

1.3.4 Except for products, material or equipment designated in the Bidding Documents for evaluation of substitutions prior to award, requests for substitution, including the data required by Paragraph 1.3.1, must be submitted to the University's Representative not later than 35 days after the date of commencement specified in the Notice to Proceed for Phase 1. No requests for substitutions of products, material or equipment subject to the 35-day deadline shall be considered unless the request and supporting data is submitted on or before the deadline, except those deemed, in University's Representative's sole opinion, to be necessary because (i) previously specified or approved manufactured products, material or equipment are no longer manufactured, (ii) of University initiated change orders, or (iii) it is in the best interest of University to accept such substitution.

1.3.5 If a product, material or equipment is designated in the Bidding Documents for evaluation of substitutions prior to award, then a request for substitution of the product, material or equipment, including the data required by Paragraph 1.3.1, must be submitted by the deadline specified in the Bidding Documents. Because of time constraints, only one submittal will be allowed for each such substitution request. Requests for substitutions of products, material or equipment designated for evaluation prior to award may not be made after the deadline specified in the Bidding Documents, and such requests be shall not be considered unless the request and supporting data is submitted on or before the deadline specified in the Bidding Documents. Notwithstanding the forgoing, the University may consider, after award of the Contract, requests for substitution of a product, material or equipment designated for evaluation prior to award where, in University's Representative's sole opinion, a substitution is necessary because (i) previously specified or approved manufactured products, material or equipment are no longer manufactured, (ii) of University initiated change orders, or (iii) it is in the best interest of University to accept such substitution.

1.3.6 In reviewing the supporting data submitted for substitutions, University's Representative will use, for purposes of comparison, all the characteristics of the specified material or equipment as they appear in the manufacturer's published data even though all the characteristics may not have been particularly mentioned in the Specifications. If more than 2 submissions of supporting data are required, the cost of reviewing the additional supporting data shall be at CM/Contractor's expense.

1.3.7 CM/Contractor has the burden of demonstrating, through the procedures specified herein, that its proposed substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and complies with all other requirements of the plans and specifications. If revisions or modifications to the design or construction of the work are necessitated by the use of the substitution, CM/Contractor also has the burden of demonstrating, through the procedures specified herein, that the use of the substitution will not be detrimental to the quality, utility or appearance of the Project or any portion of the Project.

1.3.8 The University's Representative may refuse to approve any requested substitution where, in the reasonable opinion of the University's Representative, CM/Contractor has failed to demonstrate, through the procedures specified herein, that the proposed substitution is equal to, or superior to, the first-named product, material or equipment, in quality, utility and appearance and that the proposed substitution complies with all other requirements of the plans and specifications.

1.3.9 University's Representative may reject any substitution not proposed in the manner and within the time limits prescribed herein.

1.3.10 Substitutions are not allowed unless approved in writing by the University's Representative. Any such approval shall not relieve CM/Contractor from the requirements of the Contract Documents.

1.3.11 The 35-day and 70-day submittal periods do not excuse CM/Contractor from completing the Work within the Contract Time or excuse CM/Contractor from paying liquidated damages if Final Completion is delayed.

1.3.12 If revisions or modifications to the design or construction of the Work are necessitated by the use of a substitution, the substitution may be used only if the revisions and modifications are approved in writing by the University's Representative. The University's Representative may refuse to approve any such proposed revisions or modifications where, in the reasonable opinion of the University's Representative, CM/Contractor has failed to demonstrate, through the procedures specified herein, that the revisions or modifications are not detrimental to the quality, utility and appearance of the Project or any portion of the Project.

1.3.13 If a substitution request is finally rejected by the University Representative, CM/Contractor shall furnish and install:

.1 the first-named product, material, or equipment; or

.2 a product, material, or equipment, other than the first-named product, material or equipment, specified by both brand or trade name and model number, provided CM/Contractor complies with the submittal requirements (including deadlines) of specification section 01630-1.2

1.4. Special Requirements for Bid Packages

1.4.1 CM/Contractor understands and agrees that a Subcontractor may submit to CM/Contractor a request for product substitution within the specified time after the Notice to Proceed for its Bid Package(s). Subject to approval of University's Representative, CM/Contractor may elect to require Subcontractor to submit product substitution requests prior to Bid Deadline for a Bid Package. If CM/Contractor elects to require any submittal of such product substitution requests prior to the Bid Deadline for a Bid Package, CM/Contractor shall:

.1 Insert in the Contract Schedule for the Bid Package a time for review of such product substitution request by University's Representative. Such time for review shall not be less than 10 days;

.2 Insert appropriate language in the Advertisement for Bids for the Bid Package; and

.3 Establish a deadline for submittal of product substitution requests in the Bidding Documents for the Bid Package.

1.4.2 CM/Contractor shall include the following provisions in each Bid Package and CM/Contractor shall insert in these provisions deadlines that allow sufficient time for transmittal of submittals to University's Representative within the required 35-day and 70-day submittal periods:

1.4.2.1 General Provisions Regarding Specification Of Products, Material or Equipment By Brand Or Trade Name.

1.4.2.1.1 Products, material or equipment specified by both brand or trade name and model number are approved for use, provided that Subcontractor complies with all Contract

requirements. Specification of a product, material or equipment by brand or trade name and model number is not a representation or warranty that the product, material or equipment can be used without modification, to meet the requirements of the plans and specifications; Subcontractor shall, at its sole cost, modify such products, material, or equipment so that they comply with all requirements of the plans and specifications.

1.4.2.1.2 The first-named product, material or equipment specified by brand or trade name and model number is the basis for the Project design and the use of any item other than the first-named one may require modifications of that design. If Subcontractor uses any product, material or equipment other than the first-named one, Subcontractor shall, at its sole cost:

.1 Make all revisions and modifications to the design and construction of the Work necessitated by the use the product, material or equipment.

.2 Be responsible for all costs of any changes resulting from the use of the product, material or equipment including without limitation, costs or changes which affect other parts of the Work, the work of Separate Contractors, or any other property or operations of the University.

1.4.2.1.3. When a product, material or equipment specified by brand or trade name is followed by the words “or equal,” a substitution may be permitted if the substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and if the substitution complies with all other requirements of the plans and specifications.

1.4.2.1.4 A product, material or equipment specified by brand or trade name followed by the words “or equal, no known equal,” signifies that University does not have sufficient knowledge to specify a product, material or equipment, other than the one specified by brand or trade name, that is suitable for use on the Project. The use of the words "no known equal" is not intended to discourage substitution requests in accordance with the requirements specified herein.

1.4.2.1.5 When catalog numbers and specific brands or trade names not followed by the designation "or equal" are used in conjunction with a product, material or equipment required by the specifications, substitutions will not be allowed and the named product, material or equipment must be used.

1.4.2.1.6 Specification of a product, material or equipment by brand or trade name and model number is not a representation or warranty that the product, material or equipment is available; Subcontractor should confirm, prior to submitting its Bid, the availability of any product, material or equipment specified by brand or trade name and model number.

1.4.2.2. Special Requirements For Products, Material Or Equipment, Other Than The First-Named Product, Material Or Equipment, Specified By Both Brand Or Trade Name And Model Number.

1.4.2.2.1 In addition to complying with all other submittal requirements of the Contract, submit to CM/Contractor within {65} days after the date of commencement specified in the Notice to Proceed, for review and approval by the University’s Representative, Subcontractor prepared specifications and drawings, including design and engineering calculations, prepared by an appropriate licensed professional, depicting all revisions and modifications to the design and construction of the Work necessitated by the use of the product, material or equipment. If no revisions or modifications are necessary, submit within {65} days after the date of commencement specified in the Notice to Proceed, a written representation that no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment. Subcontractor shall utilize the first-named product, material or equipment if Subcontractor fails to make the appropriate required submittal pursuant to this paragraph within the {65}-day period.

1.4.2.2.2 A product, material or equipment, other than the first-named product, material or equipment, specified by both brand or trade name and model number may be used if no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment. If such revisions or modifications are necessary, the product, material or equipment may be used only if the revisions or modifications are approved in writing by the University's Representative. Subcontractor has the burden of demonstrating, through the procedures specified herein, that any such revisions or modifications will not be detrimental to the quality, utility or appearance of the Project or any portion of the Project. The University's Representative may refuse to approve any such proposed revisions or modifications where, in the reasonable opinion of the University's Representative, Subcontractor has failed to demonstrate, through the procedures specified herein, that the revisions or modifications are not detrimental to the quality, utility or appearance of the Project or any portion of the Project.

1.4.2.3. Special Requirements For Substitutions.

1.4.2.3.1 In addition to complying with all other submittal requirements of the Contract, submit to CM/Contractor written data demonstrating that the proposed substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and otherwise complies with all requirements of the plans and specifications, including:

.1 Complete technical data including drawings, performance specifications, samples, and test reports of the article proposed for substitution.

.2 Statement by Subcontractor that the proposed substitution is in full compliance with the requirements of the Contract Documents and Applicable Code Requirements.

.3 List of Subcontractors, if any, that may be affected by the substitution.

.4 Subcontractor prepared specifications and drawings, including design and engineering calculations, prepared by an appropriately licensed professional, depicting all revisions and modifications to the design and construction of the Work necessitated by the use of the substitution. If no revisions or modifications are necessary, submit a written representation that no revisions or modifications to the design or construction of the Work are necessitated by the use of the product, material or equipment.

1.4.2.3.2 At the request of and within the timeframes specified by the University's Representative:

.1 Submit to CM/Contractor samples as deemed necessary by the University's Representative to evaluate the proposed substitution.

.2 Submit proposed substitution to tests deemed necessary by the University's Representative to evaluate the proposed substitution. Such tests shall be made by an independent Testing Laboratory and at the sole expense of Subcontractor, after review and approval of the test procedures by University's Representative. If re-testing is deemed necessary by the University's Representative to evaluate the proposed substitution, such re-testing shall be made by an independent Testing Laboratory at the sole expense of the Subcontractor.

.3 Provide to CM/Contractor any additional information deemed necessary by the University's Representative to evaluate the proposed substitution.

1.4.2.3.3 If University's Representative, in reviewing a proposed substitution, requires revisions or corrections to be made to previously accepted shop drawings and supplemental supporting data to be resubmitted, Subcontractor shall do so within the time period specified by the University's Representative. A proposed substitution may be rejected if Subcontractor fails to submit such revisions, corrections, or supplemental supporting data to CM/Contractor within the specified time period.

1.4.2.3.4 Except for products, material or equipment designated in the Bidding Documents for evaluation of substitutions prior to award, requests for substitution, including the data required by Paragraph 1.4.2.3.1, must be submitted to CM/Contractor not later than {30} days after the date of commencement specified in the Notice to Proceed. No requests for substitutions of products, material or equipment subject to the {30}-day deadline shall be considered unless the request and supporting data is submitted on or before the deadline, except those deemed, in University's Representative's sole opinion, to be necessary because (i) previously specified or approved manufactured products, material or equipment are no longer manufactured, (ii) of University initiated change orders, or (iii) it is in the best interest of University to accept such substitution.

1.4.2.3.5 If a product, material or equipment is designated in the Bidding Documents for evaluation of substitutions prior to award, then a request for substitution of the product, material or equipment, including the data required by Paragraph 1.4.2.3.1, must be submitted to CM/Contractor by the deadline specified in the Bidding Documents. Because of time constraints, only one submittal will be allowed for each such substitution request. Requests for substitutions of products, material or equipment designated for evaluation prior to award may not be made after the deadline specified in the Bidding Documents, and such requests be shall not be considered unless the request and supporting data is submitted on or before the deadline specified in the Bidding Documents. Notwithstanding the forgoing, the University may consider, after award of the Contract, requests for substitution of a product, material or equipment designated for evaluation prior to award where, in University's Representative's sole opinion, a substitution is necessary because (i) previously specified or approved manufactured products, material or equipment are no longer manufactured, (ii) of University initiated change orders, or (iii) it is in the best interest of University to accept such substitution.

1.4.2.3.6 In reviewing the supporting data submitted for substitutions, University's Representative will use, for purposes of comparison, all the characteristics of the specified material or equipment as they appear in the manufacturer's published data even though all the characteristics may not have been particularly mentioned in the Specifications. If more than 2 submissions of supporting data are required, the cost of reviewing the additional supporting data shall be at Subcontractor's expense.

1.4.2.3.7 Subcontractor has the burden of demonstrating, through the procedures specified herein, that its proposed substitution is equal to or superior to the first-named product, material or equipment in quality, utility and appearance and complies with all other requirements of the plans and specifications. If revisions or modifications to the design or construction of the work are necessitated by the use of the substitution, Subcontractor also has the burden of demonstrating, through the procedures specified herein, that the use of the substitution will not be detrimental to the quality, utility or appearance of the Project or any portion of the Project.

1.4.2.3.8 The University’s Representative may refuse to approve any requested substitution where, in the reasonable opinion of the University’s Representative, Subcontractor has failed to demonstrate, through the procedures specified herein, that the proposed substitution is equal to, or superior to, the first-named product, material or equipment, in quality, utility and appearance and that the proposed substitution complies with all other requirements of the plans and specifications.

1.4.2.3.9 University's Representative may reject any substitution not proposed in the manner and within the time limits prescribed herein.

1.4.2.3.10 Substitutions are not allowed unless approved in writing by the University's Representative. Any such approval shall not relieve Subcontractor from the requirements of the Contract Documents.

1.4.2.3.11 If revisions or modifications to the design or construction of the Work are necessitated by the use of a substitution, the substitution may be used only if the revisions and modifications are approved in writing by the University's Representative. The University's Representative may refuse to approve any such proposed revisions or modifications where, in the reasonable opinion of the University's Representative, Subcontractor has failed to demonstrate, through the procedures specified herein, that the revisions or modifications are not detrimental to the quality, utility and appearance of the Project or any portion of the Project.

1.4.2.3.12. If a substitution request is finally rejected by the University Representative, Subcontractor shall furnish and install:

.1 the first-named product, material, or equipment; or

.2 a product, material, or equipment, other than the first-named product, material or equipment, specified by both brand or trade name and model number, provided Subcontractor complies with the submittal requirements (including deadlines) of specification section 01630-1.4

END OF SECTION

SECTION 01 71 00
EXAMINATION AND PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
1. Mobilization – Not Used
2. Acceptance of Conditions
3. Construction Layout – Not Used
4. Construction Surveying – Not Used
5. Protection of Adjacent Construction – Not Used
6. Non-Destructive Concrete Examination – Not Used

1.2 MOBILIZATION – NOT USED

1.3 ACCEPTANCE OF CONDITIONS

A. Contractor and University Site Review
1. Prior to commencing the Work, the Contractor and University's Representative shall tour together the Project site (and areas immediately surrounding the site) to examine and record damage to existing buildings and improvements constructed under a prior contract. As such the Contractor accepts the work constructed on site "as–is" and must finish what is installed into a complete and functional system.
2. This record shall serve as a basis for determination of subsequent damage due to Contractor's operations and shall be signed by all parties making the tour. Any cracks, sags, or damage to the adjacent buildings, improvements and landscaping elements not noted in the original survey, but subsequently discovered, shall be reported to University's Representative within 15 days from Notice to Proceed.
3. The Contractor shall prepare a report of the survey, including:
   a. DVD recording of existing conditions.
   b. 8" x 10" glossy photographs of significant features requested by University's Representative.
   c. Key plan with references to video/photographs
4. The Contractor and University Representative shall periodically monitor conditions of existing buildings and installations for signs of movement, settlement, or other damage related to construction.
5. Contractor is solely responsible for repairing damage to existing construction and finishes and for replacing damaged components, which cannot be repaired.
6. Contractor is solely responsible for maintaining and watering existing landscaping within the Project site and for replacing landscaping elements, which are damaged or destroyed during the course of the Work.

1.4 CONSTRUCTION LAYOUT – NOT USED

1.5 CONSTRUCTION SURVEYING – NOT USED

1.6 PROTECTION OF ADJACENT CONSTRUCTION – NOT USED

1.7 NON-DESTRUCTIVE CONCRETE EXAMINATION – NOT USED

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 71 21
SPECIALTY ENGINEERING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish engineering design, drawings and calculations for Specialty Engineering Requirements, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 DEFINITIONS

A. Structural Engineer of Record (SER):
1. Structural engineer legally eligible to seal structural Contract Documents for project.
2. Seal acknowledges SER performed or supervised analysis, design, and document preparation for building structure and has knowledge of requirements for structural system.
3. The SER is responsible for the design of the primary structural system.

B. Specialty Structural Engineer (SSE):
1. Registered Engineer other than Structural Engineer of Record (SER), licensed to practice structural engineering in state in which project is located.
2. Undertakes engineering calculations, design and drawing preparation of components, systems, or installation methods and equipment for specific temporary portions of Work or special items of permanent Work required to be furnished by Contractor.
3. Provide designs and details for items of permanent Work declared to be minor or non-structural.
4. Employee or officer of Contractor or fabricator, employee or officer of an entity providing components to a fabricator, or an independent consultant.
5. The Contractor is responsible for any structural engineering tasks that are required for construction related services.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM DESIGN

A. Contract Documents show conceptually detailed components describing aesthetic intent and provides a performance-type prescription for the design, fabrication and installation.

B. Contractor is responsible for the engineering and design of components and materials as well as fabrication and installation.

C. Develop conditions not shown in Contract Documents to same level of aesthetics in compliance with performance and aesthetic criteria specified and indicated for detailed areas.

D. Provide engineering design with drawings and calculations sealed by registered Engineer, licensed to practice structural engineering where the project is located.

E. Comply with requirements of Contract Documents, codes, regulations, standards and guidelines including:
1. Nationally published amendments.
2. Local Amendments.
3. Structural criteria provided.
4. Additional requirements indicated in specification sections.

F. Reference Standards:
   1. Refer to technical specification sections for listed standards.
   2. Refer to Section 01 42 00 for edition of each standard indicated.

G. Minor deviations in dimensions and profiles may be considered provided design concept is unchanged or intended performance is not compromised as judged by the Architect.

H. Where SSE exercises professional judgment and takes exception to specified criteria or reference standards, disclose exception in writing.

3.2 DOCUMENTATION

A. Include following items common to project:
   1. Project Identification
      a. Project name
      b. Project location
      c. Identifying project numbers
      d. North arrow
      e. Scale
   2. Governing Codes
      a. Building code and edition
      b. Referenced codes and standards
      c. Design method used for the design
   3. Service Loads
   4. Strength loads or factors
   5. Design Load
      a. Dead loads
      b. Live loads
      c. Snow loads
      d. Wind loads
      e. Seismic loads
   6. Material Properties
      a. Design properties
      b. ASTM designations
   7. Computer Submittals
      a. Documentation of computer programs including the program name and version should be included with any submittal of computer calculations. In the case of custom software or spreadsheet developed in house it may be necessary to provide hand calculation of representative elements to verify the use of the program.

B. Include maximum design loads at connection points to primary structure.
   1. Indicate values consistent with method used for design including service loads or strength loads with factors.
   2. Design system to apply loads to the structure through the centerlines of the supporting element.
   3. Assume building supports are free to rotate. Torsional or flexural fixed supports shall not be used unless approved by the SER.
   4. When fixed or eccentric supports are used, provide additional framing as deemed necessary by the SER at no additional cost.

C. Include member sizes, required reinforcing, connection details and material specifications.

D. Include statements where the SSE has exercised professional judgment and takes exception to the specified criteria or referenced standard. Final authority and responsibility for decisions concerning structural design criteria shall belong to the SER. When exceptions are stated as qualifications to the contractor's proposal, the SER shall be notified and respond prior to award.

E. SSE shall review and approve the shop drawings and special erection drawings prepared by a fabricator or supplier and attest to that review with a signed shop drawing stamp, or other means,

prior to submittal of the drawings to the SER. When standardized erection drawings are used, there is no need to provide a shop drawing approval stamp.

END OF SECTION

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SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for cutting and patching, including without limitation, the following:
   1. Submittals
   2. Quality Assurance
   3. Warranty
   4. Materials
   5. Inspection
   6. Preparation
   7. Performance
   8. Cleaning

B. Requirements of this Section apply to mechanical and electrical installations. Refer to Specification Divisions 20-28 for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

C. Refer to other applicable Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

D. Cutting and Patching, in addition to requirements of the General Conditions, includes removing, altering, and repairing portions of the Work as required to accomplish the following:
   1. Make several parts fit properly.
   2. Uncover work to provide for installation of ill-timed work.
   3. Remove and replace defective work.
   4. Remove samples of installed work as specified or requested by the University's Representative for testing.
   5. Install new construction penetrations of or connections to existing construction.

1.2 SUBMITTALS

A. Cutting and Patching Proposal: Submit written notice to the University's Representative requesting permission to proceed with cutting which could affect structural safety of the project 10 days in advance of starting cutting. Request approval to proceed. Include the following information, as applicable, in the proposal:
   1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.
   2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
   3. List products to be used and firms or entities that will perform Work.
   4. Indicate dates when cutting and patching will be performed.
   5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. All utility shut downs shall be kept to a minimum. Contractor shall coordinate for all shut downs to occur during weekend hours without change to the contract sum. Identify date, time and expected duration (no more than 8 hours duration) of all utility shutdowns. There will be no shut downs for sewer services, must do bypass.
   6. Approval by the University's Representative to proceed with cutting and patching does not waive the University's Representative right to later require complete removal and replacement of unsatisfactory work.

B. Changed Conditions Notice: Submit written recommendations to the University's Representative should conditions of work or schedule indicate change of materials or methods, including the following:
   1. Conditions indicating change.
   2. Recommendations for alternative materials and methods.
   3. Information required for substitution.

1.3 QUALITY ASSURANCE

A. Requirements for Structural Work:
   1. Obtain approval of the cutting and patching proposal before cutting and patching structural elements including, but not limited to, the following:
      a. Foundation construction.
      b. Structural concrete.
      c. Miscellaneous structural metals.
      d. Piping and equipment.

B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
   1. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems
      a. Primary operational systems and equipment.
      b. Fire protection systems.
      c. Communication systems.
      d. Electrical wiring systems.
      e. Security systems

C. Visual Requirements: Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patch in a visually unsatisfactory manner.

1.4 WARRANTY

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action and notify University's Representative before proceeding.
   1. Before proceeding, meet at the Project Site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

2. Provide drawings and calculations signed by a licensed California Structural Engineer for shoring, bracing and support to maintain structural integrity.
3. Protect other portions of the Project.
4. Protect Project from the element.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit, or ductwork serving the building but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 PERFORMANCE

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer's recommendations.
1. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
3. Cut through concrete and masonry using a cutting machine, such as a Carborundum saw or a diamond-core drill.
4. Comply with requirements applicable Division 02 Sections where cutting and patching requires excavating and backfilling.
5. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.4 CLEANING

A. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar items. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION

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SECTION 01 74 00
CLEANING AND WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Progress Cleaning and Site Maintenance
   2. Construction Waste Management and Disposal
   3. Final Cleaning
   4. Contractor C&D Waste Monitoring Form and Green Waste Monitoring Form, copies of which are attached at the end of this Section

B. Cleaning Agents: Use cleaning materials and agents recommended by the 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.

C. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and antipollution regulations.
   1. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in streams, storm or sanitary drains.
   2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.
   3. Comply with requirements of Southern California Air Quality Management District in effect at the time of construction.
   4. Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.

D. Submittal: Prior to requesting inspection for Substantial Completion and Final Completion, submit written certification to the University's Representative that final cleaning has been performed in accordance with the Contract Documents.

1.2 PROGRESS CLEANING AND SITE MAINTENANCE

A. Collection and Disposal of Waste: Contractor shall furnish all labor, equipment, containers, transportation, materials, supplies and related expenses to provide the University with comprehensive waste collection and waste recycling services for the Project. Contractor shall collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degree F (27 degree C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly.
   1. Do not burn waste materials. Do not bury debris or excess materials on the University's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems or streams. Remove waste materials from the site and dispose of lawfully.
   2. Where extra materials of value remain after completion of associated Work, they become the University's property. Dispose of these materials as directed by the University's Representative.
   3. Provide on-site containers for collection of waste materials, debris, and rubbish, and empty at least weekly. Maintain containers in such condition so as to ensure they are clean and sanitary, to prevent odor and insect infestation, and ensure no unsightly presentation. Perform maintenance on the containers as required to ensure proper function for the intended purpose.

4. Handle waste materials in a controlled manner. Do not drop or throw materials from heights.
5. Remove combustible debris from the building daily and store in covered, non-combustible containers located not less than 40 feet from any building.

B. Cleaning During Construction Period: Comply with regulations of the University and safety standards for cleaning.
1. Schedule cleaning operations so that dust and other contaminants resulting from cleaning operations will not settle on wet paint, or other coatings or finishes during their cure period.
2. Comply with manufacturer's instructions for cleaning the surfaces and parts of finishes and equipment. Use only those cleaning materials and procedures recommended by the manufacturer of the item to be cleaned.
3. Provide cleaning during construction as necessary to ensure operations can proceed on schedule and that finish materials can be installed properly and viewed for determination of aesthetic characteristics.

1.3 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

A. The University has established that this Project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible shall be employed to enable the University to meet a minimum 95 percent diversion of construction and demolition (C&D) waste (including green waste) from the landfill.

B. Contractor shall be responsible for monitoring and maintaining a written log using the C&D Waste Monitoring Form and Green Waste Monitoring Form, copies of which are attached at the end of this Section, to report when actual container deliveries and waste pickups occur, the types of C&D waste material included, weight of each type (in Tons) diverted or landfilled and total percentage of waste diverted from landfill, and any other data required to be reported on the respective forms. Contractor shall submit completed forms with the required data to University's Representative, or designee, **with each Application for Payment**. Such written information shall be used as backup to support payment of Contractor's scheduled value for Division 1, General Requirements.

C. C&D waste is a combination of concrete, lumber, plaster, cardboard, glass, various metals, paper, PVC, ABS, HDPE, PP, PDPE, PET, white foam, paint buckets, carpet, green waste, and dirt.
1. C&D waste accepted for recycling:
   a. Card Board.
   b. Mixed metals.
   c. PVC Pipe.
   d. ABS Pipe.
   e. H.D.P.E. Pipe.
   f. Carpet.
   g. Carpet Pad.
   h. Mixed Plastics.
   i. Glass.
   j. Bottles & Cans – CRV.
   k. H.D.P.E Plastics.
   l. H.D.P.E Pipe.
   m. Foam – White.
   n. Paper – Mixed.
   o. Plastic Buckets – Paint (empty) & Landscapers.
   p. Drywall.
   q. Wood.
   r. Particle Board.

s. Green Waste:
   1) Green Waste refers to waste resulting from removal of vegetation; it is a combination of brush, branches, leaves, flowers, shrubs and small trees and other items listed on the Green Waste Monitoring Form.
   2) Green Waste accepted for recycling and/or compost:
      a) Grass Clippings.
      b) Trees – Tree trunks shall be cut into 4' and 10" pieces.
      c) Branches – Branches shall be cut into 4' and 10" pieces.
      d) Tree Trimmings – All other material other than trunks, branches, and leaves.
      e) Wood.
      f) Mulch.
      g) Brush.
      h) Leaves.
      i) Flowers.
      j) Shrubs.
      k) Palm Fronds.

t. Inert Material – Soil, Asphalt, Brick, Concrete

1.4 FINAL CLEANING

A. This Section includes the administrative and procedural requirements for final cleaning at Substantial Completion and Final Inspection.

B. Provide final-cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial cleaning and maintenance program. Comply with manufacturer's instructions.

C. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.
   1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and foreign substances.
   2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   3. Remove petrochemical spills, stains, and other foreign deposits.
   4. Remove tools, construction equipment, machinery, and surplus material from the site.
   5. Remove snow and ice, if any, to provide safe access to the building.
   6. 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.
   7. Remove debris and surface dust from limited access spaces, including trenches, equipment vaults, manholes and similar spaces.
   8. Broom clean concrete floors in unoccupied spaces.
   9. Remove labels that are not permanent labels.
   10. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
   11. Wipe surfaces of electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   12. Remove grease, dust, dirt, stains, and other marks from surfaces exposed-to-view.
   13. Leave the Project clean.

D. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects, and other pests. Comply with regulations of local authorities.

E. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

F. Where extra materials of value remain after completion of associated Work, they become the University's property. Dispose of these materials as directed by the University's Representative at no additional cost to the University.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

Contractor C&D Waste Monitoring Form

Project Name & No.:

Contractor:

Prepared by:

Date/Time of Pick up	Size of Bin	R/L[1]	Bin Makeup: Recycled or Landfill Materials (Provide quantity of each in Tons)											
			Concrete	Metals	Wood	Glass	Clay/Brick	Paper	Gypsum	Paint	Insulation	Green Waste[2]	Dirt[2]	Other
Column Totals:														
Total C&D Waste to Landfill:														
% of C&D Waste Recycled:														

[1] Indicate whether R=Recycled or L=Landfill.
[2] For waste diversion numbers, Green Waste and dirt are not included. Complete Green Waste Monitoring Form.

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Contractor Green Waste Monitoring Form

Project Name & No.:

Contractor:

Prepared by:

Date/Time of Pick up	Size of Bin	R/L[1]	Bin Makeup: Recycled or Landfill Materials (Provide quantity of each in Tons)											
			Grass Clippings	Small Tree	Tree Trunks	Branches	Tree Trimmings	Wood	Mulch	Brush	Leaves	Flowers	Shrubs	Palm Fronds
Column Totals:														
Total Green Waste to Landfill:														
% of Green Waste Recycled:														

[1] Indicate whether R=Recycled or L=Landfill.

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SECTION 01 77 00
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:
   1. Substantial Completion
   2. Final Inspection Acceptance
   3. Closeout Procedures
   4. Instruction and Evaluation of University's Personnel
   5. Training Tools and Materials
   6. Qualifications of Instructors
   7. Operation and Maintenance Manuals and Instructions
   8. Spare Parts and Extra Stock Materials
   9. Warranties

B. Closeout requirements for specific construction activities are included in the appropriate Sections in Divisions 02 through 28.

1.2 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
      a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
      b. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
   2. Advise the University of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance and service agreements, final certifications, and similar documents.
   4. Obtain and submit releases enabling the University unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Submit record drawings, operation and maintenance manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra stock, and similar items.
   7. Make final changeover of permanent locks and transmit keys and key schedule to the University. Advise the University's personnel of changeover in security provisions.
   8. Complete startup testing of systems and instruction of the University's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with construction tools and similar elements.
   9. Complete final cleanup requirements, including touchup painting.
   10. Touch up and otherwise repair and restore marred, exposed finishes.
   11. Adjust and balance all systems and adjust all valves.
   12. Check fluid and gas carrying pipe systems, roofs, flashings, gutters, and downspouts for leaks. Repair or replace as necessary.
   13. Lubricate all moving parts of machinery and equipment as recommended by the manufacturers of the machinery and equipment.
   14. Submit certification required in Section 01 74 00 for "Final Cleaning."

B. Inspection Procedures: On receipt of a request for inspection, the University's Representative will either proceed with inspection or advise the Contractor of incomplete or incorrect work. The University's Representative will prepare the Punchlist following inspection or advise the Contractor of what must be completed or corrected before the certificate will be issued.
   1. The University's Representative will repeat inspection when requested and assured that the Work is substantially complete.
   2. Results of the completed inspection will form the basis of requirements for final acceptance.
   3. Allow 3 weeks for the University's Representative to prepare the list of items to be corrected.

1.3 FINAL INSPECTION ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
   1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
   2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
   3. Submit a certified copy of the University Representative's final inspection list of items to be completed or corrected, endorsed and dated by the University's Representative. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the University's Representative.
   4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the University took possession of and assumed responsibility for corresponding elements of the Work.
   5. Submit consent of surety to final payment.
   6. Submit a final liquidated damages settlement statement.
   7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   8. Completed Punchlist.

B. Reinspection Procedure: The University's Representative will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the University's Representative.
   1. Upon completion of reinspection, the University's Representative will prepare a certificate of final acceptance. If the Work is incomplete, the University's Representative will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
   2. If necessary, reinspection will be repeated and related costs of University's Representative and University Representative's Consultants will be deducted from final retention payment.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

A. Operation and Maintenance Instructions: Arrange for each Installer of equipment that requires regular maintenance to meet with the University's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
   1. Operation and Maintenance manuals.
   2. As-Built documents.

3. Spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Startup.
2. Shutdown.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

3.2 INSTRUCTION AND EVALUATION OF UNIVERSITY'S PERSONNEL

A. Perform hands-on demonstrations and instruction for University's designated personnel in the operation, adjustment and maintenance of products, equipment, and systems, as required and at agreed upon times.

B. Instruction Before Final Inspection: Before Final Inspection, and after work under this contract is completed, tested and prior to acceptance by the University; and not less than five (5) days after submittal of the Operation and Maintenance Data, operate all the systems for a period of three (3) 8-hour periods during which time a qualified factory trained representative familiar with the items installed shall instruct and supervise the University's Personnel in the operation and maintenance of the equipment and systems. This instruction period is in addition and subsequent to any period of operation, testing and adjustment called for elsewhere in these specifications.

C. Instruction by Manufacturer's Representatives: Any instructions from manufacturer's representatives required under other sections of this specification shall be conducted during this period. This instruction period shall be conducted after completion of all piping and equipment labeling required by the Contract.

D. Time of Instructions: Make all arrangements and notices for operation and instruction periods though the University's Representative.

E. Seasonal Operation: For equipment requiring seasonal operation, perform demonstrations and instructions for each required season and at agreed upon times.

F. Evaluation: During and after demonstrations and instructions for University's designated personnel, evaluate their ability to perform the necessary maintenance and operation functions required to properly operate and maintain each piece of equipment. Make sure that at the end of the training session, the University's designated personnel are reasonably proficient in the operations and maintenance of products, systems, and equipment.

3.3 TRAINING TOOLS AND MATERIALS

A. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance. For all systems requiring operation and maintenance training from factory representative, written authorization from the University is required. All systems of more than one manufacturer, a factory representative from each will be required.

B. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

3.4 QUALIFICATIONS OF INSTRUCTORS

A. Instructions for the University's Personnel. For instruction of the University's operating and maintenance personnel, use experienced instructors thoroughly trained and experienced in the operation and maintenance of the building equipment or system involved.

3.5 OPERATION AND MAINTENANCE MANUALS AND INSTRUCTIONS

A. Assemble and furnish a minimum of 3 complete sets (unless otherwise indicated in a specific section) of all mechanical and electrical systems data, except that noted to be mounted in frames, in three-ring loose-leaf binders, complete with index, with indexed dividers permanently attached and exterior labels on cover and back of binders.

B. Data Required:
   1. Manufacturers' Manuals: Provide complete installation, operation, maintenance, and service manuals and printed instructions and parts lists for all materials and equipment, where such printed matter is regularly available from the manufacturer. This includes but is not limited to such service manuals as may be sold by the manufacturer covering the operation and maintenance of items, and complete replacement parts lists sufficiently detailed for parts replacement ordering to manufacturer. Bound publications need not be assembled in binders.
   2. Equipment Nameplate Data: A typewritten list of all mechanical and electrical equipment showing all equipment nameplate data exactly. Identify equipment by means of names, symbols, and numbers used in the Contract Documents.
   3. System Operating Instructions: Typewritten instructions covering operation of the entire system as installed (not duplicating manufacturers' instructions for operating individual components). Include schematic flow and control diagrams as appropriate and show, locate, or list system valves, control-elements, and equipment components using identification symbols and numbers. List rooms, area of equipment served, and show proper settings for valves, controls, and switches.
   4. System Maintenance Instructions: Typewritten instructions covering routine maintenance of systems. List each item of equipment requiring inspection, lubrication, or service and briefly describe such maintenance, including types of lubricants and frequency of service. It is not intended that these instructions duplicate manufacturers' detailed instructions. Give name, address, and phone number of nearest firm authorized or qualified to service equipment or provide parts.
   5. Warranty, Bonds, and Service Contracts: Provide a copy of each warranty, bond, and service contract issued. These should be accompanied by a sheet which outlines procedures to take in the event of failure and the circumstances which might affect the validity of warranties or bonds.
   6. Wall Mounted Data: Frame one set of typewritten system instructions and diagrams as required under Paragraphs 3 and 4 above, covered with plexiglass and mount in locations as directed by the University's Representative.

3.6 SPARE PARTS AND EXTRA STOCK MATERIALS

3.7 WARRANTIES

A. General Provisions:
   1. This subsection includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers' standard warranties on products and special warranties.
      a. Refer to the General Conditions for terms of the Contractor's period for correction of the Work.
      b. Refer to Divisions 2 through 33 for specific requirements for warranties on products and installations specified to be warranted.

c. Certifications and other commitments and agreements for continuing services to University are specified elsewhere in the Contract Documents.

2. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
3. Effective Date: Warranties shall begin on the date of Final Acceptance unless specifically designated differently or a different date is mutually agreed upon in writing by the parties involved.
4. General Conditions require all items to be under warranty for a period of one (1) year from date of final completion (Notice of Completion) unless otherwise indicated. Warranties for more than one year required by individual Sections require a written warranty by Contractor and Subcontractor. Refer to individual Section of the Specifications to verify if longer warranties are required.

B. Definitions:
1. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the University.
2. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the University.

C. Warranty Requirements
1. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
2. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
3. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Regents have benefited from use of the Work through a portion of its anticipated useful service life.
4. Regents' Recourse: Expressed warranties made to the Regents are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Regents can enforce such other duties, obligations, rights, or remedies.
   a. Rejection of Warranties: The Regents reserve the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   b. The Regents reserve the right to reuse to accept Work for the Project where a special guarantee, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented so that entities required to countersign such commitments are willing to do so.
5. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the University reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.
6. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on standard product warranties shall not relieve the Contractor of the Contractor's warranty on the Work

that incorporates the products, and shall also not relieve suppliers, manufacturers, and subcontractors required to counter-sign special warranties with the Contractor.

D. Warranty Submittals
   1. Submit written warranties to the University's Representative prior to the date certified for Substantial Completion. If the University Representative's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion, or a designated portion of the Work, submit written warranties upon request of the University's Representative.
      a. When a designated portion of the Work is completed and occupied or used by the University, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the University's Representative within 10 days of completion of that designated portion of the Work.
   2. Forms for special warranties are included at the end of this Section. Prepare a written document utilizing the appropriate form, ready for execution by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Submit a draft to the University, through the University's Representative, for approval prior to final execution.
      a. Refer to Divisions 2 through 33 for specific content requirements and particular requirements for submitting special warranties.
   3. Form of Submittal: At Final Completion compile 3 copies of each required warranty, in the form included at the end of this Section, properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   4. Assemble required guarantees, bonds, and service and maintenance contracts.
   5. Number of original signed copies required: Three (3) sets, each on 8-1/2 inch x 11 inch sheets, 3-hole punched in 3-ring binders. Fold larger sheets to fit into binders. Submit in commercial quality, 3-ring binders, with durable, cleanable plastic covers. Each set of binders shall include:
      a. Cover: Identify each binder on the cover with typed or printed title, "WARRANTIES", University's Project Name and Number, Name of General Contractor, and binder number, such as "Set 1, Volume 1 of 2", etc.
      b. Table of Contents: in a spreadsheet/table format, neatly typed and in orderly sequence by CSI number, based on Specifications Table of Contents in the Bidding-Contract Documents, with the following information:
         1) CSI Number.
         2) Name of Product or Work item.
         3) Brief Scope Description.
         4) Firm name, address, telephone number, and name of principal with email address.
         5) Date of beginning of guarantee, bond, or service and maintenance contract.
         6) Duration and expiration date of warranty or service and maintenance contract.
      c. When warranted, construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.
      d. Except when a special warranty is required by the provisions of a specific Section of these Specifications, or a standard warranty is not offered as a matter of record by the manufacturer of a specified product, submit the manufacturer's standard warranty for each product incorporated in the Work.
      e. When a manufacturer does not offer a standard warranty, provide a written form listing the product and indicating "Standard Product Warranty Not Available."
   6. Special Warranty Forms: Attached at the end of this Section.

END OF SECTION

GUARANTEE

Project Name: _____ Date:_____

Project Location: _____

Project Number: _____

GUARANTEE FOR _____ _____ (the "Contract"), between
(Specification SECTION and Contract No.)

The Regents of the University of California ("University") and

_____
("Contractor")

_____
(Name of Contractor or Subcontractor)

hereby guarantees to University that the portion of the Work described as follows:

_____
_____
_____
_____
_____
_____
_____

which it has provided for the above referenced Project, is of good quality; free from defects; free from any liens, claims, and security interests; and has been completed in accordance with Specification SECTION and the other requirements of the Contract.

The undersigned further agrees that, if at any time within _____ months after the date of the guarantee the undersigned receives notice from University that the aforesaid portion of the Work is unsatisfactory, faulty, deficient, incomplete, or not in conformance with the requirements of the Contract, the undersigned will, within 10 days after receipt of such notice, correct, repair, or replace such portion of the Work, together with any other parts of the Work and any other property which is damaged or destroyed as a result of such defective portion of the Work or the correction, repair, or replacement thereof; and that it shall diligently and continuously prosecute such correction, repair, or replacement to completion.

In the event the undersigned fails to commence such correction, repair, or replacement within 10 days after such notice, or to diligently and continuously prosecute the same to completion, the undersigned, collectively and separately, do hereby authorize University to undertake such correction, repair, or replacement at the expense of the undersigned; and Contractor will pay to University promptly upon demand all costs and expenses incurred by University in connection therewith.

SUBCONTRACTOR

Signed: _____ Title: _____
Typed Name:_____
Name of Firm: _____
Contractor License Classification and Number: _____
Address: _____
Telephone Number: _____

CONTRACTOR

Signed: _____ Title: _____
Typed Name: _____
Name of Firm: _____

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SPECIAL WARRANTY FORM

When required in Sections of the Specifications, Special Warranties shall be in the following form and written on Contractor's own letterhead:

"Warrant: _____
(portion of work warranted)

Project:_____

Address:_____

Date: _____

We, the undersigned hereby warrant to the Regents of the University of California ("Regents") that the portion of the work identified, which we have installed in the above-named Project has been performed in accordance with the Contract Documents and that the work, as installed, will fulfill the requirements of the warranty included in this Specification. We agree to repair or replace any or all of our work, together with any other work which may be damaged or displaced by so doing, that may prove to be defective in its workmanship, materials, operation, or failure to conform to Contract provisions and requirements within a period of year(s) from date of Substantial Completion of the stipulated below for the above-named Project, without any expense whatever to the said Regents, ordinary wear and tear and unusual abuse or neglect excepted. In the event of our failure to comply with the above-mentioned conditions within ten (10) calendar days after being notified in writing by the Regents, we collectively or separately do hereby authorize the Regents to proceed to have said defects repaired and made good at our expense, including all collection cost and reasonable attorney fees, and we will honor and pay the costs and charges therefore upon demand."

WARRANTY PERIOD: _____ STARTING: _____ TERMINATING _____

Name of General Contractor	Name of Subcontractor
_____	_____
_____	_____
Signature of General Contractor	Signature of Subcontractor
_____	_____
Address	Address
_____	_____
Phone Number	Phone Number
_____	_____
State License Number	State License Number
_____	_____
Name of Manufacturer	Manufacturer Phone Number

_____
Signature of Manufacturer

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SECTION 01 78 39
AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for As-Built Documents, including without limitation, the following:
   1. As-Built Drawings
   2. As-Built Specifications
   3. As-Built Product Data
   4. As-Built Sample Submittal
   5. Miscellaneous As-Built Submittals
   6. Recording

B. As-Built Documents required include the following:
   1. Marked-up copies of Drawings.
   2. Marked-up copies of Shop Drawings.
   3. Newly prepared drawings.
   4. Marked-up copies of Specifications, Addenda, and Change Orders.
   5. Marked-up Product Data submittals.
   6. Samples.
   7. Field records for variable and concealed conditions.
   8. Record information on Work that is recorded only schematically.
   9. Operation and Maintenance Data submittals.
   10. Miscellaneous submittals.

C. Maintenance of Documents and Samples: Store As-Built Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use As-Built Documents for construction purposes. Maintain As-Built Documents in good order, legible condition, and in a clean, dry, secure, fire-safe location. Make As-Built Documents and Samples available at all times for the University's Representative's inspections.
   1. Maintain 1 set of all As-Built Documents at the Project site for the entire duration of construction.
   2. Clearly label each document or item "AS-BUILT DRAWING," "AS-BUILT SAMPLE," "AS-BUILT SPECIFICATION," or similarly as appropriate and applicable.

D. Do not conceal Work requiring verification for As-Built Documents until such information has been verified and recorded.

1.2 AS-BUILT DRAWINGS

A. Markup Procedure: During construction, maintain a clean, undamaged set of blue- or black-line white prints of Contract Drawings and Shop Drawings for As-Built Document purposes.
   1. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
      a. Dimensional changes to the Drawings.
      b. Revisions to details shown on the Drawings.
      c. Depths of foundations below the first floor. Indicate foundation elevations relative to first floor elevation.
      d. Horizontal locations and vertical depths of underground utilities and appurtenances, including both site utilities and those under buildings and structures, referenced to permanent surface improvements.

e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Changes made by change order or field order.
h. Changes made following the University Representative's written orders and pertinent graphic and written responses to RFI's.
i. Details not on original Contract Drawings.

2. Mark As-Built prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings location.
3. Mark As-Built sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
4. Mark important additional information that was either shown schematically or omitted from original Drawings. Mark new information that is important to the University but was not shown on Contract Drawings or Shop Drawings.
5. Note field order numbers, alternate numbers, change order numbers, RFI numbers, ASI numbers, and similar identification.
6. Identify and date each drawing; include the printed designation "AS-BUILT DRAWING" in a prominent location on each drawing

B. Responsibility for Markup: The individual or entity who obtained As-Built data, whether the individual or entity is the installer, subcontractor, or similar entity, shall prepare the markup on As-Built drawings.
1. Accurately information in an understandable drawing technique.
2. Record data as soon as possible after obtaining it, but within 24 hours maximum. Record and check the markup prior to enclosing concealed installations.
3. At time of Substantial Completion, submit As-Built drawings to the University's Representative for the University's records. Organize into sets and bind and label sets for the University's continued use. Bind each set with durable-paper cover sheets. Include appropriate identification, including titles, dates, and other information on the cover sheets.

C. Newly Prepared As-Built Drawings: Prepare new drawings instead of following procedures specified for preparing As-Built drawings where new drawings are required, and the University's Representative determines that neither original Contract Drawings nor Shop Drawings are suitable to show the actual installation.

D. Consult with the University's Representative for the proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. When completed and accepted, integrate newly prepared Drawings with procedures specified for organizing, copying, binding and submittal of As-Built drawings.

1.3 AS-BUILT SPECIFICATIONS

A. During the construction period, maintain 3 copies of the Specifications, including addenda and modifications issued, for As-Built Document purposes.
1. Mark the Specifications to indicate the actual installation where the installation varies from that indicated in Specifications and modifications issued. Note related project record drawing information, where applicable. Give particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later.
a. In each Specification Section where products, materials, or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.
b. Record the name of the manufacturer, supplier, installer, and other information necessary to provide a record of selections made and to document coordination with As-Built Product Data submittals and maintenance manuals.

c. Note related As-Built Product Data, where applicable. For each principal product specified, indicate whether As-Built Product Data has been submitted in maintenance manual instead of submitted as As-Built Product Data.
d. Use pen and black ink so marks will reproduce clearly.

2. Upon completion of markup, submit As-Built Specifications to the University's Representative for the University's records.

1.4 AS-BUILT PRODUCT DATA

A. During the construction period, maintain one copy of each Product Data submittal for As-Built Document purposes.
1. Mark Product Data to indicate the actual product installation where the installation varies substantially from that indicated in Product Data submitted. Include significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation.
2. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
3. Note related change orders and markup of As-Built Drawings, where applicable.
4. Upon completion of markup, submit a complete set of As-Built Product Data to the University's Representative for the University's records.
5. Where As-Built Product Data is required as part of maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as As-Built Product Data.

1.5 AS-BUILT SAMPLE SUBMITTAL

A. Immediately prior to date of Substantial Completion meet with the University's Representative and the University's personnel at the site to determine which of the Samples maintained during the construction period shall be transmitted to the University for record purposes. Comply with the University Representative's instructions for packaging, identification marking, and delivery to the University's Sample storage space. Dispose of other Samples in a manner specified for disposing surplus and waste materials.

1.6 MISCELLANEOUS AS-BUILT SUBMITTALS

A. Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous As-Built records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the University's Representative for the University's records.
1. Categories of requirements resulting in miscellaneous As-Built Documents include, but are not limited to, the following:
a. Field records on excavations and foundations.
b. Field records on underground construction and similar work.
c. Survey showing locations and elevations of underground lines.
d. Invert elevations of drainage piping.
e. Surveys establishing building lines and levels.
f. Authorized measurements utilizing unit prices or allowances.
g. Records of plant treatment.
h. Ambient and substrate condition tests.
i. Certifications received in lieu of labels on bulk products.
j. Batch mixing and bulk delivery records.
k. Testing and qualification of tradesmen.
l. Documented qualification of installation firms.
m. Load and performance testing.
n. Inspections and certifications by governing authorities.
o. Leakage and water-penetration tests.
p. Final inspection and correction procedures.
q. Field test reports.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 RECORDING

A. Post changes and modifications to the As-Built Documents as they occur. Do not wait until the end of the Project. The University's Representative and IOR will periodically review As-Built Documents to determine compliance with this requirement.

B. Current updated As-Built Documents shall be made available to the University's Representative and IOR for review at the time of submitting applications for payment.

C. Per the General Conditions, the University has the right to withhold payment until As-Built Documents are completed and current to date as of the latest application for payment.

END OF SECTION

SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned:
   1. Commissioning Team
   2. University's Responsibilities
   3. Contractor's Responsibilities
   4. CxA's Responsibilities
   5. Commissioning Documentation
   6. Submittals
   7. Quality Assurance
   8. Title 24 Acceptance Testing
   9. Start-up, Pre-Functional Checklists and Initial Checkout
   10. Functional Performance Testing
   11. Operation and Maintenance Training Requirements
   12. Costs of Commissioning Work
   13. Equipment and System Schedule

B. Related Sections:
   1. Fire suppression systems
   2. Plumbing systems
   3. HVAC systems, including Controls or Integrated Automation.
   4. Lighting and other electrical systems.
   5. Communications and Data systems.
   6. Safety and security systems.

C. Basis of Design (BOD) and Owner's Project Requirements (OPR) documentation prepared by University contains requirements that apply to this Section. This information is available to Bidders upon request.

D. Comply with the Acceptance Testing requirements of Title 24 Energy Code and ACM (Alternative Calculation Method) Approval Manual. Additional requirements are given in Part 3 of this Section.

1.2 DEFINITIONS

A. Commissioning Process: The basic purpose of building commissioning is to provide documented confirmation that building systems function in compliance with criteria set forth in the Project Documents to satisfy the owner's operational needs.

B. Basis of Design (BOD) document: A document that records concepts, calculations, decisions, product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

C. CxA: Commissioning Authority.

D. University Project Requirements (OPR): A written document, prepared by the University, that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.

E. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

F. TAB: Testing, Adjusting, and Balancing.

G. Title 24: California Code of Regulations, Title 24, Part 1 - Building Energy Efficiency Standards (latest edition).

1.3 COMMISSIONING TEAM

A. Members Appointed by Contractor: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by University:
1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner may engage the independent CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.4 UNIVERSITY'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and Contractor for use in developing the commissioning plan; systems manual; operation and maintenance training plan; and testing plans and checklists.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to the following:
1. Coordination meetings.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Testing meetings.
4. Demonstration of operation of systems, subsystems, and equipment.

C. Provide the BOD documents, prepared by University or its consultants, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Provide utility services required for the commissioning process.

B. Contractor is responsible for construction means, methods, job safety, and/or management function related to commissioning on the job site.

C. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
1. Participate in construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in operation and maintenance training sessions.
4. Participate in final review at acceptance meeting.
5. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
7. Review and comment on final commissioning documentation.

D. Contractor shall integrate all commissioning activities into Contractor's master construction schedule.

E. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
   1. Participate in construction-phase coordination meetings.
   2. Participate in maintenance orientation and inspection.
   3. Participate in procedures meeting for testing.
   4. Participate in final review at acceptance meeting.
   5. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
   6. Provide information to the CxA for developing construction-phase commissioning plan.
   7. Participate in training sessions for University's operation and maintenance personnel.
   8. Provide updated Project Record Documents to the CxA on a daily basis.
   9. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data" (Section 01 77 00).
   10. Provide technicians who are familiar with the construction and operation of installed systems, who shall execute the test procedures developed by the CxA, and who shall participate in testing of installed systems, subsystems, and equipment.

1.6 CXA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Conduct a commissioning design review of the OPR, BOD, and design documents prior to mid-construction documents phase and back-check the review comments in the subsequent design submissions, in accordance with LEED credit EA3 “Enhanced Commissioning”.

C. Prepare a construction-phase commissioning plan. Collaborate with design team, University, Contractor and with subcontractors to develop test and inspection procedures. Include design changes and scheduled commissioning activities coordinated with overall Project schedule. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

D. Work with the University to schedule commissioning activities. All parties will address scheduling issues in a timely manner in order to expedite the commissioning process.

E. Review and comment on submittals from Contractor for compliance with the OPR, BOD, Contract Documents, and construction-phase commissioning plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BOD.

F. Convene commissioning team meetings on a monthly basis for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five (5) workdays of the commissioning meeting.

G. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.

H. Observe and inspect construction and report progress and deficiencies. In addition to compliance with the OPR, BOD, and Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

I. Prepare Project-specific test and inspection procedures and checklists.

J. Schedule, direct, witness, and document tests, inspections, and systems startup.

K. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.

L. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

M. Review Project Record Documents for accuracy. Request revisions from Contractor to achieve accuracy. Project Record Documents requirements are specified in Division 01 Section "Project Record Documents" (Section 01 78 39).

N. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BoD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data" (Section 01 77 00)

O. Review Contractor's operation and maintenance training program. Operation and maintenance training is specified in Division 01 Section "Demonstration and Training" (Section 01 77 00)

P. Obtain the services of a professional agency to video the training sessions where required by individual Specification Sections.

Q. Video construction progress including hidden shafts.

R. Prepare commissioning reports.

S. Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.

1.7 COMMISSIONING DOCUMENTATION

A. Index of Commissioning Documents: CxA shall prepare an index to include storage location of each document.

B. Commissioning Plan: A document, prepared by CxA, that outlines the schedule, allocation of resources, documentation requirements of the commissioning process, and shall include, but is not limited to the following:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
3. Identification of systems and equipment to be commissioned.
4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
5. Identification of items that must be completed before the next operation can proceed.
6. Description of responsibilities of commissioning team members.
7. Description of observations to be made.
8. Description of requirements for operation and maintenance training, including required training materials.
9. Description of expected performance for systems, subsystems, equipment, and controls.
10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
11. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.
12. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
13. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.

14. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.

C. Pre-Functional Checklists: CxA shall develop pre-functional checklists for all equipment to be commissioned. Further requirements are specified in Part 3 of this Section.

D. Functional Performance Testing: CxA shall develop functional performance test procedures for all equipment and systems to be commissioned. Further requirements are specified in Part 3 of this Section.

E. Certificate of Readiness: Certificate of Readiness shall be signed by Contractor, Subcontractor(s), and installer(s) certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate.

F. Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

G. Corrective Action Documents: CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

H. Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the OPR, BoD, and Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
   1. Creating an Issues Log Entry:
      a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
      b. Assign a descriptive title of the issue.
      c. Identify date and time of the issue.
      d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
      e. Identify system, subsystem, and equipment to which the issue applies.
      f. Identify location of system, subsystem, and equipment.
      g. Include information that may be helpful in diagnosing or evaluating the issue.
      h. Note recommended corrective action.
      i. Identify commissioning team member responsible for corrective action.
      j. Identify expected date of correction.
      k. Identify person documenting the issue.
   2. Documenting Issue Resolution:
      a. Log date correction is completed or the issue is resolved.
      b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
      c. Identify changes to the OPR, BOD, or Contract Documents that may require action.
      d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
      e. Identify person(s) who corrected or resolved the issue.
      f. Identify person(s) documenting the issue resolution.

I. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are

performing according to the OPR, BOD, and Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the OPR, BOD, and Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during University occupancy and operation. It shall describe components and performance that exceed requirements of the OPR, BOD, and Contract Documents and those that do not meet requirements of the OPR, BOD, and Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
2. OPR and BOD documentation.
3. Commissioning plan.
4. Testing plans and reports.
5. Corrective modification documentation.
6. Issues log.
7. Completed test checklists.
8. Listing of off-season test(s) not performed and a schedule for their completion.

J. Systems Manual: CxA shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. OPR and BOD, including system narratives, schematics, and changes made throughout the Project.
2. Project Record Documents as specified in Division 01 Section "Project Record Documents" (Section 01 78 39).
3. Final commissioning plan.
4. Commissioning report.
5. Operation and maintenance data as specified in Division 01 Section "Operation and Maintenance Data" (Section 01 77 00).

1.8 SUBMITTALS

The CxA shall submit the following:

A. Commissioning Plan Prefinal Submittal: Submit three (3) hard copies of pre-final commissioning plan. Deliver one copy to Contractor, one to Owner, and one to University Consultant. Present submittal in sufficient detail to evaluate data collection and arrangement process. One copy, with review comments, will be returned to the CxA for preparation of the final construction-phase commissioning plan.

B. Commissioning Plan Final Submittal: Submit three (3) hard copies and two sets of electronically formatted information of final commissioning plan. Deliver one hard copy and one set of discs to University, and one copy to University Consultant. The final submittal must address previous review comments. The final submittal shall include a copy of the pre-final submittal review comments along with a response to each item.

C. Test Checklists and Report Forms: Submit sample checklists and forms to Contractor quality-control manager and subcontractors for review and comment. Submit three (3) copies of each checklist and report form.

D. Certificates of Readiness.

E. Test and Inspection Reports.

F. Corrective Action Documents.

G. Pre-final Commissioning Report Submittal: Submit three (3) hard copies of the pre-final commissioning report. Include a copy of the preliminary submittal review comments along with CxA's response to each item. CxA shall deliver one copy to University and one copy to University Consultant. One copy, with review comments, will be returned to the CxA for preparation of final submittal.

H. Final Commissioning Report Submittal and LEED™ Documentation: Submit three (3) hard copies and three (3) sets of electronically formatted information of the final commissioning report. The final submittal must address previous review comments and shall include a copy of the pre-final submittal review comments along with a response to each item.

I. Recommissioning Management Manual: Develop an indexed Recommissioning Management Manual to be delivered to the Owner with the final commissioning report. Include all components listed in the LEED Reference Guide.

J. LEED™ Documentation. Compile LEED™ Documentation. Format as required by USGBC for submittal under LEED™ rating system.

1.9 QUALITY ASSURANCE

A. Training Instructor Qualifications: Contractor shall provide factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

B. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments (per NIST requirements if applicable) immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

C. CxA shall coordinate the following:
   1. Coordinating Meetings: Conduct regular coordination meetings of the commissioning team at least monthly to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
   2. Pretesting Meetings: Conduct pretest meetings of the commissioning team to review startup reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.
   3. Testing Coordination: Coordinate sequence of testing activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
      a. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TITLE 24 ACCEPTANCE TESTING

A. Comply with the requirements of Title 24, and Appendix NJ of the Nonresidential Alternative Calculation Method (ACM) Approval Manual.
   1. The installing Contractor shall be responsible for reviewing the plans and specifications to assure they conform to the Acceptance Requirements. This is typically done prior to signing a Certificate of Compliance.
   2. The installing Contractor shall be responsible for providing all necessary instrumentation, measurement and monitoring, and undertaking all required acceptance requirement procedures. They shall be responsible for correcting all performance deficiencies and again implementing the acceptance requirement procedures until all specified systems and equipment are performing in accordance with the Standards.
   3. The installing Contractor shall be responsible for documenting the results of the acceptance requirement procedures including paper and electronic copies of all measurement and monitoring results. They shall be responsible for performing data analysis, calculation of performance indices and crosschecking results with the requirements of the Standard. They shall be responsible for issuing a Certificate of Acceptance. The University shall not release

a final Certificate of Occupancy until a Certificate of Acceptance is submitted that demonstrates that the specified systems and equipment have been shown to be performing in accordance with the Standards.

4. The installing Contractor upon completion of undertaking all required acceptance requirement procedures shall record their State of California Contractor's License number or their State of California Professional Registration License Number on each Certificate of Acceptance that they issue.

3.2 START-UP, PRE-FUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to all equipment to be commissioned.

B. General. Pre-functional Checklists are developed and completed for all major equipment and systems being commissioned. The checklist captures equipment nameplate and characteristics data, confirming the as-built status of the equipment or system. These checklists also ensure that the systems are complete and operational, so that the functional performance testing can be scheduled. The checklists are created by the CxA and completed (filled out) by the installing Contractor.

C. Start-up and Initial Checkout Plan. The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

D. Pre-functional Checklists. The CxA shall create pre-functional checklists, based primarily on the manufacturer's startup and initial checkout procedures are created. Each checkout item shall have a place to document that proper installation has occurred. Once the pre-functional checklist is completed by the installing Contractor, this signifies that the equipment is properly installed per manufacturer's procedures, and the controls and TAB are complete and the equipment is ready for final functional performance testing. The Contractor determines which Sub-contractor is responsible for executing and documenting each of the line item tasks.

E. Sensor Calibration. Calibration of all sensors shall be included as part of the pre-functional checklists performed by the Contractors.

F. Execution of Pre-functional Checklists and Startup.
   1. Sub-contractors and vendors schedule startup and checkout with the University, Contractor, and CxA.
   2. The CxA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are repetitive multiple units, (in which case a sampling strategy may be used as approved by the University).
   3. For lower-level components of equipment in non-sensitive areas of the Project, (e.g., VAV boxes, reheat coils), the CxA shall observe a sampling of the pre-functional and start-up procedures.
   4. The Contractor and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and pre-functional checklists.
   5. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional checklist was actually performed shall initial or check that item off.

G. Deficiencies, Non-Conformance and Approval in Checklists and Startup.
   1. The Contractor shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
   2. The CxA reviews the report and recommends approval to the University. The CxA shall work with the Contractor and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the University and others as necessary.

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, 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, low oil pressure, no flow, equipment failure, etc. shall also be tested.

B. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The 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. The CxA shall review University-contracted or factory testing which the CxA is not responsible to oversee and shall determine what further testing may be required to comply with the Contract Documents. Redundancy of testing shall be minimized.

The test procedure forms developed by the CxA shall include the following information:

1. System and equipment or component name(s).
2. Equipment location and ID number.
3. Date.
4. Project name and University Project Number.
5. Participating parties.
6. Reference to the specification section describing the test requirements.
7. A copy of the specific sequence of operations.
8. Instructions for setting up the test.
9. Special cautions, alarm limits, etc.
10. Specific step-by-step procedures to execute the test.
11. Acceptance criteria of proper performance with a Yes / No check box.
12. A section for comments.
13. Signatures and date block for the CxA.

C. Test Methods.

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA will determine which method is most appropriate.
2. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
3. Sampling. Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy will be developed by the CxA and approved by the University. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units are tested at the Contractor's expense.

D. Coordination and Scheduling. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the University Representative and Contractor. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractor shall execute the tests.

E. Problem Solving. The CxA will recommend solutions to problems found; however the burden of responsibility to solve, correct and retest problems is with the Contractor and University consultants.

3.4 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

A. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. In addition to requirements specified in Division 01 Section "Demonstration and Training" (Section 01 77 00) perform the following:
1. Review the OPR and BoD.
2. Review installed systems, subsystems, and equipment.
3. Review instructor qualifications.
4. Review instructional methods and procedures.
5. Review training module outlines and contents.
6. Review course materials (including operation and maintenance manuals).
7. Inspect and discuss locations and other facilities required for instruction.
8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

B. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment as specified in Division 01 Section "Demonstration and Training" (Section 01 77 00)

3.5 COSTS OF COMMISSIONING WORK

A. The cost of the CxA shall be borne by the University.

B. The cost to the Contractor and Subcontractors to comply with the specified requirements and to support the work of the CxA shall be included in the Contractor's and Subcontractor's bid price.

C. If a device, piece of equipment, sequence, or system fails a test, corrections shall be made and a second test shall be performed. If the second test is not successful, then the CxA's cost for a third test or subsequent tests shall be reimbursed to the CxA by the Contractor.

3.6 EQUIPMENT & SYSTEM SCHEDULE

A. The following equipment shall be commissioned in this Project.

System	Equipment	Note
HVAC System	Pumps	
	Variable frequency drives	
	Air handlers	
	Packaged AC units	
	Air terminal units for High Occupancy rooms	
	Air terminal units for Office and Laboratory areas	2
	Air terminal valves for Laboratory areas	
	Heat exchangers	
	Condensate return units	
	Exhaust fans	
	Supply fans	
	Return fans	
Building Energy Management System (EMS)	Sequences of Operation, Monitored Points, Control Points, and Alarms	
	Metering/Monitoring Devices and Equipment	
	Software Commissioning, GUI presentation commissioning, system access performance criteria, software tools/source code commissioning, instrument data sheets, middleware commissioning, Internet Protocol commissioning	

System	Equipment	Note
Lighting and Shade Control System	Sequences of Operation, Monitored points, control points, user controls	
Electrical System	Sweep or scheduled lighting controls	2
	Daylight dimming controls	
	Lighting occupancy sensors	
	Electrical grounding	
Plumbing System	Domestic water heaters	
	Pumps	
	Air compressors	
	Compressed air dryers	
	Vacuum pumps	
Security Alarm Systems	Security cameras and monitoring system personal duress alarm system; Intercom system; Paging System.	
Security Electronics	Security plumbing fixture water management system.	
Seminar/ Conference Rooms	Door Controls.	
	Fire alarm system.	
	Distributed radio antenna system.	
	Access control system	
	Room acoustics.	
Fire/Life Safety Systems	Sound masking system.	
	Assisted listening.	
	Video projection.	
	Audio system.	
	Lighting and lighting controls.	
	All devices	
Communication System	Alarm drivers	
	HVAC/Fire System Integration	
	Event Notifying and Reporting Systems	

Notes:

1. Centralized equipment should be fully commissioned.
2. Items which represent multiple, identical repetitive equipment may be tested on a “sampling” or “spot-check” basis, 20% of total.

END OF SECTION

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SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Demolition, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Conduct work in accordance with OSHA and EPA requirements.

B. National Fire Protection Association (NFPA):
   1. NFPA 241 Standards for Safeguarding Construction, Alteration, and Demolition Operations.

C. Design, engineering, and construction of shoring, bracing and supports are responsibility of Contractor.
   1. Employ a Registered Engineer, licensed to practice structural engineering in state in which project is located.
   2. Design to support dead, live, and lateral, wind or seismic loads required by code or otherwise indicated, along with construction loads during demolition until permanent construction is in place.

1.3 DESCRIPTION

A. Work Includes:
   1. Demolition of designated structures.
   2. Removal of demolition debris.
   3. Protection of construction to remain, including:
      a. Utilities.
      b. Other items indicated.

B. Condition of Existing Structures to be Demolished:
   1. Owner assumes no responsibility for actual condition of structures to be demolished.
   2. Owner will maintain building conditions existing at time of inspection for bidding purposes insofar as practicable.

C. Standpipes:
   1. Maintain in operable condition and available for use by fire department.
   2. Do not demolish more than one floor below floor being demolished.

1.4 JOB CONDITIONS

A. Perform preliminary investigations to ascertain extent of work.
   1. Conditions apparent by investigation shall not be allowed as claim for extra cost.

B. Obtain and pay for permits required by authorities having jurisdiction and notify interested utilities companies prior to commencement of activities.

C. Obtain approval of authorities having jurisdiction for work affecting existing means of egress.
   1. Review with and obtain approval of authorities for temporary construction which affects such areas.
   2. Obtain approval of fire authorities.

D. Separate, store and dispose of hazardous materials and toxic wastes in accordance with local and EPA regulations and criteria listed below:
   1. Disposal of fluorescent light tubes in open containers is not permitted.
   2. Disposal of ballasts and other building elements containing PCBs in open containers is not permitted.
   3. Disposal of building elements containing mercury in open containers is not permitted.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL DEMOLITION PROCEDURES

A. Items Designated for Re-use:
   1. Remove, tag, protect from damage, store and deliver to locations designated.
   2. Brace motors attached to flexible mountings until reinstallation.

B. Demolition of Structures:
   1. Demolish completely and remove from site.
   2. Use such methods as required to complete work within limitations of governing regulations.
   3. Coordinate with Owner and utility suppliers for shut-off of utilities serving each building.
   4. Disconnect and seal utilities before commencement of demolition.

C. Structural Demolition:
   1. Demolish concrete and masonry in small sections.
   2. Perform removal to avoid excessive loads on supporting walls, floors or framing.

D. Existing Utilities to Remain.
   1. Keep in service and protect against damage during demolition.
   2. Do not interrupt existing utilities serving occupied or facilities in use, except as authorized by Owner.
   3. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.

E. Conduct operations to insure minimum interference with roads, walks, entrances, exits, and adjacent facilities.
   1. Do not close or obstruct private drives, walks or other facilities unless approved in writing.
   2. Do not close or obstruct exits from existing facilities or obstruct public thoroughfares and walks without approval of authorities having jurisdiction.
   3. Provide alternate routes around closed or obstructed traffic ways.

F. Provide covered passageways to ensure safe passage of persons in or near areas of work.

G. Provide barricades and safety lights as required.

3.2 PROTECTION OF FACILITIES TO REMAIN

A. Protect Property to Remain:
   1. Conduct operations to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities as well as persons.
   2. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures.

B. Protect occupants from injury and discomfort.

C. Provide temporary dustproof partitions between demolition areas and occupied areas.
   1. In public areas use clean, painted 1/2 IN thick plywood.
   2. Utilize fire rated construction where required by Authorities Having Jurisdiction.

D. Provide temporary weather protection and insulation to prevent damage to existing facilities and discomfort to persons in occupied areas.
   1. Insulation value: R 19.

3.3 ITEMS SALVAGED FOR OWNER

A. Remove salvage items at appropriate stage of demolition, but early enough to prevent damage to them by demolition operations:
   1. Coordinate with Owner items Owner wishes to save.

B. Remove salvage items as a unit:
   1. Clean, list, and tag for storage.
   2. Protect from damage.
   3. Salvage each item with auxiliary or associated equipment required for operation.
   4. Store in an area designated within building.

3.4 ITEMS SALVAGED FOR CONTRACTOR

A. Items of salvage value to Contractor may be removed from structure as work progresses.

B. Transport salvaged items from site as they are removed.

C. Storage or sale of removed items not permitted on site.

3.5 CLEAN-UP AND DISPOSAL OF DEMOLITION MATERIALS

A. Remove debris, rubbish, and materials resulting from demolition operations.
   1. Remove and legally dispose of off site.
   2. Do not burn materials on site.

B. Dispose of items and materials not designated for Owner salvage or reuse.
   1. Promptly remove from site.
   2. Do not store or sell Contractor salvaged items or materials on site.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations.

D. Return adjacent areas to condition existing prior to start of work.

END OF SECTION

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SECTION 03 08 13
CONCRETE TESTING AND EVALUATION - OWNER

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Testing and Evaluation - Owner, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in Field
   2. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   3. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

B. American Concrete Institute (ACI):
   1. ACI 318 Building Code Requirements for Structural Concrete and Commentary

C. Testing Agency:
   1. Acceptable to Architect.
   2. Recent evidence of inspection by Cement and Concrete Reference Laboratory of National Institute of Standards and Technology, with cited deficiencies corrected.
   3. Meet requirements of ASTM E329.
   4. Agency and its representatives are not authorized to revoke, alter, relax, enlarge or release requirements, nor approve or accept portion of Contract Documents.

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. For each type of material and accessory.

C. Project Information:
   1. Testing Agency qualifications.
   2. Production sample test reports, when required:
      a. Include same data as that required for mix designs.
   3. Reports of Contractor option tests.
   4. Test reports on in-place testing, if such testing is performed.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 DESCRIPTION

A. Test concrete materials and inspect operations as work progresses.

B. Failure to detect defective work or material shall not prevent later rejection when such defect is discovered nor shall it obligate Architect for final acceptance.

C. Payment for Testing:
   1. Pay for testing services required in paragraph Article 3.2, following.

2. Routine testing of concrete furnished to job site for compliance with Contract Documents will be performed by Owner's testing agency at Owner's expense.
   a. Test for compressive strength, slump, air content, temperature and unit weight.
   b. Perform tests every 75 CU YD or fraction thereof, for each mixture design placed in one day.
   c. Obtain composite samples in accordance with ASTM C172.
      1) Obtain each sample from a different batch of concrete on a random basis.
      2) Select test batch at random before commencement of concrete placement.
   d. Mold and cure sufficient specimens from each sample in accordance with ASTM C31 and report deviations from requirements, if any.
   e. Coordinate number of specimens with test specification requirements and construction operations.
   f. Test specimens in accordance with ASTM C39.

3.2 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

A. Provide testing services performed by Testing Agency for qualification of proposed materials and establishment of mix designs.

B. Submit concrete materials and concrete mix designs.
   1. Include results of testing performed to qualify materials and establish mix designs

C. Place no concrete until Contractor has received approval.

D. Use of testing service shall not relieve Contractor of responsibility to furnish materials and construction in compliance with Contract Documents.

E. Testing and Inspection:
   1. Furnish labor to assist Owner's Testing Agency in obtaining and handling samples or other materials at site.
   2. Advise Owner's Testing Agency in advance of operations.
   3. Provide and maintain facilities for storage and curing of concrete compressive strength test specimens on site for first 24 HRS or until strength is achieved as required by ASTM C31.

F. Pay for following additional testing services performed by Owner's testing agency when:
   1. When changes in materials or proportions are requested by Contractor Additional testing and inspection.
   2. When specimens fail to meet specification requirements, by test or inspection.
   3. Testing services needed or required by Contractor.
      a. Field-cured test specimens as needed for control of stripped, reshored, unshored, post-tensioned concrete work.

3.3 EVALUATION AND ACCEPTANCE OF COMPRESSIVE STRENGTH TEST RESULTS

A. Evaluate test results for standard molded and cured test cylinders separately for each concrete mix design.
   1. Evaluate each mix design for strength and uniformity by a minimum of five tests.

B. Strength level of concrete shall be considered acceptable when average of three consecutive strength test sets equal or exceed specified strength (f'c) and no individual strength test result is less than specified strength (f'c) by more than 500 PSI.

3.4 TESTING CONCRETE IN PLACE

A. Test concrete in place when compressive strength tests indicate potential strength deficiency to evaluate actual strength.
   1. Pay for concrete tests and engineering time and analysis required to evaluate in-place concrete strength as result of deficient cylinder strength tests.

B. Testing by rebound hammer, ultrasonic, or other non-destructive device.
   1. Tests shall be used to determine relative strengths at various locations in structure to determine areas to be cored.
   2. Calibrated and correlated tests with other test data shall be used as basis for acceptance or rejection.

C. Core Tests:
   1. Obtain and test largest practical diameter cores, 2 IN minimum, in accordance with ASTM C42.
      a. Test dry if concrete in structure will be dry under service conditions,
         1) Air dry cores at 60 DEGF to 80 DEGF, relative humidity less than 60 PCT for 7 days before test.
      b. Test cores after moisture conditioning if concrete in structure is more than superficially wet under service conditions.
   2. Take three cores from area of concrete or member considered deficient in strength.
      a. Location as selected by Architect.
      b. Replace cores damaged prior or during removal from structure prior to testing.
   3. Concrete core test shall be considered acceptable if average strength of cores is equal to at least 85 PCT of, with no single core less than 75 PCT of specified strength (f'c).
   4. Fill core holes with low slump patching compound per Section 03 35 00.

3.5 ACCEPTANCE OR REJECTION OF CAST-IN-PLACE CONCRETE

A. General:
   1. Completed concrete work which conforms to requirements of Contract Documents will be accepted without qualification.
   2. Concrete work which fails to conform to one or more requirements of Contract Documents shall be rejected and will not be accepted until repaired and proven adequate by concrete testing.
   3. Contractor pays costs incurred in providing remedial work necessary to change rejected work to accepted work.
   4. Remedial work includes, but is not necessarily limited to, applicable repairs, replacement, reinforcement, engineering, and testing.
   5. Repair or replacement of concrete in an approved manner and in conformance with Contract Documents constitutes acceptance.

B. Dimensional Tolerances:
   1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to confirmation of safety by structural analysis or load test.
      a. When deficiencies are confirmed, replace or reinforce structure as directed.
   2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances will be rejected if strength or finish of structure is not acceptable, or function is adversely affected.
      a. If removal of excess material is permitted, repair of surfaces constitutes acceptance.
      b. If removal of excess material is not permitted, replacement of surfaces constitute acceptance.
   3. Concrete members cast in wrong location will be rejected if: strength or finish is not acceptable, function is adversely affected, and /or interference is encountered with other construction.
   4. Inaccurately formed concrete surfaces exceeding tolerances and exposed to view will be rejected.

C. Finish:
   1. Architectural concrete with surface exceeding limitations will be rejected.
   2. Concrete exposed to view with defects which adversely affect appearance of specified finish may be repaired only by approved methods.

3. Slabs:
   a. Finished slabs exceeding tolerance limits specified in Section 03 35 00 will be rejected if finish is not acceptable and function is adversely affected.
      1) If rejected, repair of finished surfaces or replacement of slab in an approved manner and in conformance with Contract Documents will constitute acceptance.
   b. Repair may involve removing high spots by grinding, filling low spots with patching compound, or remedial measures as permitted.
4. Formed surfaces:
   a. Concrete exposed to view with defects which adversely affect appearance of specified finish will be rejected.
      1) Repair surface defects in conformance with Section 03 35 00.
5. Concrete not exposed to view is not subject to rejection for defective finish.

D. Strength of Structure:
1. Concrete in place which control strength of structure will be rejected if it fails to comply with requirements of Contract Documents, including but not necessarily limited to:
   a. Deficient concrete strength based on compressive strength tests.
   b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with requirements on reinforcement.
   c. Concrete which differs from required dimensions or location.
   d. Curing less than that specified.
   e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
   f. Mechanical injury, construction fires, accidents or premature removal of formwork.
   g. Substandard workmanship.
2. When strength of structure is considered potentially deficient, it will not be accepted until one of following is completed and submitted to Architect for approval prior to action by Contractor.
   a. Confirmation of safety of structure by structural analysis.
   b. Core tests shall be performed only when safety of structure is not confirmed by structural analysis.
   c. Confirmation of safety of structure by load tests performed and evaluated in accordance with ACI 318.
   d. Replacement of structure deficient in strength.
   e. Reinforce structure with supplement supports as directed by Architect and approved by Owner.

END OF SECTION

SECTION 03 11 00
CONCRETE FORMING

PART 1- GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Formwork, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Design, engineering, and construction of formwork are responsibility of Contractor.
   1. Design, engineer, and construct formwork for applicable gravity and lateral loads and pressures as well as other design considerations or applicable requirements of legal local building code.
   2. Develop shoring and re-shoring pattern and sequence so as not to exceed safe structural capacity of supporting structural systems. Confer with Architect, if there is any question, regarding the capacity of the structural system.

B. Design, prepare formwork drawings and construct formwork in accordance with ACI 347, Guide to Formwork for Concrete.

C. Layout and measurement of concrete forms and embedment's, required for work, performed by a licensed surveyor employed by the contractor.

1.3 QUALITY ASSURANCE

A. Standards:
   1. California Administrative Code, Title 24.
   2. California Administrative Code, Title 22.

B. Design, engineering and construction of formwork is responsibility of Contractor. Formwork must be designed and engineered by Structural Engineer, licensed in State of California and having experience in this work of at least 5 similar projects in last 5 years.
   1. Design, engineer, and construct formwork for applicable gravity and lateral loads and pressures, as well as other design considerations or applicable requirements of Title 22, Division 7, Chapter 7, and Title 24, Part 6, Division T22 of California Administrative Code and legal local building code.
   2. Develop shoring and re-shoring pattern and sequence so as not to exceed safe structural capacity of supporting structural systems. Confer with Architect, if there is any question, regarding the capacity of the structural system.

1.4 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. For each type of material and accessory.

C. Project Information:
   1. Certification that formwork has been designed by Structural Engineer, licensed in State of California.

1.5 DESCRIPTION

A. Definitions:
   1. Formwork: Total system of support for freshly placed concrete including mold or sheathing which contacts concrete as well as supporting members, hardware, and necessary bracing.

2. Exposed construction: Exposed to view.
3. Exposed to view: Concrete surfaces seen by the public from eye level from any walking surface in a public location after completion of building.
4. Public location: Building areas accessible to public and employees not responsible for maintenance. Storerooms, unfinished space and large mechanical rooms are considered public locations. Equipment closets, elevator and mechanical penthouses are not public space.

B. Use forms, wherever necessary, to confine concrete and shape it to required dimensions. Use forms of sufficient strength to withstand pressure resulting from placement and vibration of concrete, with sufficient rigidity to maintain specified tolerances.

C. See concrete finish requirements in Section 03 35 00.

D. Use earth side forms for spread footings, pile caps and unfinished grade beams where earth can be shaped to a straight and true surface. Do not use earth cuts as forms for other vertical surfaces unless permitted.

PART 2 - MATERIALS

2.1 MATERIALS

A. Form facing materials: As indicated under description of finishes required.

B. Form accessories, partially or wholly embedded in concrete, such as ties and hangers: Shall be of a commercially manufactured type. Do not use non-fabricated wire. Use form ties constructed so ends or end fasteners can be removed without causing appreciable spalling of concrete faces. After ends or end fasteners of form ties have been removed, embedded portion of ties shall terminate not less than 2 diameters or twice minimum dimension of tie from formed faces of concrete to be permanently exposed to view, but in no case less than 3/4 IN. When formed face of concrete is not to be permanently exposed to view, form ties may be cut off flush with formed surfaces. Use ties with 3/4 IN diameter cones on both ends for water retaining structures.

2.2 FABRICATION OF FORMS

A. Make forms sufficiently tight to prevent loss of cement fines. Place chamfer strips in outside corners of forms to produce 45 degree beveled corners on permanently exposed surfaces. Interior corners on such surfaces and edges of formed joints will not require beveling.

B. To maintain specified finish tolerances, camber formwork to compensate for anticipated formwork deflections prior to hardening of concrete.

C. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up settlement during concrete placing operation. Securely brace forms against lateral deflection.

D. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

E. At construction joints, contact surface of form sheathing for flush surfaces exposed to view shall overlap hardened concrete in previous placement minimum 1 IN. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.

F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

G. Fasten wedges (used for final adjustment of forms prior to concrete placement) in position after final check.

H. Anchor formwork to shores or other supporting surfaces or members so upward or lateral movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

2.3 TOLERANCES

A. Construct formwork so concrete surfaces will conform to tolerance limits listed: Tolerances non-cumulative. Most restrictive tolerance governs. Tolerance limits noted are maximum deviations (plus or minus) on each side of intended line.
   1. Deviation from plumb:
      a. In lines and surfaces of columns, piers, walls, and in arrises:
         1) In any length: 1 IN 500 but not less than 1/8 IN.
         2) In any story: 3/8 IN.
         3) Maximum for entire length: 3/4 IN.
      b. For exposed corner columns, control-joint grooves, and other conspicuous vertical lines:
         1) In any length: 1 IN 1000 but not less than 1/8 IN.
         2) In any story: 3/16 IN.
         3) Maximum for entire length: 1/2 IN.
   2. Deviation from level or from grades specified:
      a. In slab soffits, ceilings, beam soffits and in arrises, measured before removal of supporting shores:
         1) In any length: 1 IN 750 but not less than 1/8 IN.
         2) In any bay: 3/8 IN.
         3) Maximum for entire length: 1/2 IN.
      b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal lines:
         1) In any length: 1 IN 1000, but not less than 1/8 IN.
         2) In any bay: 1/4 IN.
         3) Maximum for entire length: 1/2 IN.
   3. Deviations from true plane of concrete surface exposed to view caused by bulging of form facing material between supports:
      a. 3/16 IN or l/300 of span between supports whichever is smaller.
   4. Deviation from established position in plan of linear building lines, columns, walls:
      a. In any length: 1 IN 500, but not less than 1/8 IN.
      b. In any bay: 1/2 IN.
      c. Maximum for entire length: 3/4 IN.
   5. Deviation in sizes and location of sleeves, floor openings, and wall openings: 1/4 IN.
   6. Deviation in cross-sectional dimensions of columns and beams and in thickness of slabs and walls:
      a. Minus: 1/4 IN.
      b. Plus: 1/2 IN.
   7. Footings:
      a. Deviations in dimensions in plan:
         1) Minus: 1/2 IN.
         2) Plus: 2 IN.
      b. Misplacement or eccentricity:
         1) 2 PCT of footing width in direction of misplacement but not more than 2 IN.
      c. Thickness:
         1) Decrease in specified thickness: 5 PCT.
         2) Increase in specified thickness: No limit (except that which may interfere with other construction).
   8. Deviation in steps:
      a. In flight of stairs:
         1) Rise: 1/8 IN.
         2) Tread: 1/4 IN.

b. In consecutive steps:
   1) Rise: 1/16 IN.
   2) Tread: 1/8 IN.
c. Deviation from level for any step or landing: 1 IN 1000 but not more than 1/8 IN.

B. Formwork Classifications:
1. Concrete formwork shall meet the following classification requirements:
   a. Concrete noted as "Architectural Exposed Concrete: Class A."
   b. Concrete exposed to view or to receive membrane waterproofing: Class B.
   c. Footings: Class D.
   d. All other concrete: Class C.

C. Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items, except where specifically noted otherwise.

D. Establish and maintain in undisturbed condition and until final completion of project, sufficient control points and bench marks to be used for reference purposes to check tolerances.

E. Regardless of tolerances listed allow no portion of building to extend beyond property line of project.

PART 3 - EXECUTION

3.1 PREPARATION OF FORM SURFACES

A. Clean form surfaces and embedded materials of mortar, grout and foreign material before concrete is placed.

B. Before placing of reinforcing steel or concrete, treat surfaces of forms as follows:
1. Unless otherwise noted, cover surfaces of forms with nonstaining, biodegradable, form release agent to prevent absorption of moisture and prevent bond with concrete,
2. Form release agent VOC content no greater than 250 g/L.
   a. Bio-Nox by Nox-Crete Products Group, or equal.
3. Do not allow excess release agent to collect in forms or contact hardened concrete against which fresh concrete is placed.
4. Factory applied non-absorptive liner may be used.

3.2 REMOVAL OF FORMS

A. When repair of surface defects or finishing is required at early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.

B. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.

C. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

D. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

E. Where no re-shoring is planned, leave forms and shoring used to support weight of concrete in beams, slabs and other concrete members in place until concrete has attained its specified strength. Where re-shoring is planned, supporting formwork may be removed when concrete has reached 70 PCT of specified strength, provided re-shoring is installed immediately.

F. When shores and other vertical supports are arranged so non-load-carrying form-facing material may be removed without loosening or disturbing shores and supports, facing material may be removed at earlier age as permitted.

3.3 RE-SHORING

A. When re-shoring is permitted or required, plan operations in advance. Follow sequence indicated on formwork drawings as directed by forming system design engineer. While re-shoring is underway, allow no live load on new construction.

B. During re-shoring do not subject concrete in beam, slab, column or other structural member to combined dead and construction loads in excess of loads permitted by forming system design engineer for developed concrete strength at time of re-shoring. Place re-shores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs. Tighten re-shores to carry required loads without overstressing construction. Leave re-shores in place until:
   1. Tests representative of concrete being supported have reached specified strength.
   2. In-place concrete is at least 7 days old and/or meets the strength required by the forming system design engineer.
   3. Loads imposed by construction operations do not exceed design loads.

C. For floors supporting shores under newly placed concrete leave original supporting shores in place or re-shore. Re-shoring system shall have capacity sufficient to resist anticipated loads and equal to at least one half of capacity of shoring system above. Locate re-shores directly under shore position above unless otherwise permitted.

D. In multi-story buildings extend re-shoring over sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that capacity of floors as determined by design load and developed concrete strength at time of stripping and re-shoring is not exceeded.

3.4 REMOVAL STRENGTH

A. When removal of formwork or re-shoring is based on concrete reaching specified strength, concrete shall be presumed to have reached this strength when either of following conditions has been met.
   1. When test cylinders, field cured along with concrete they represent, have reached specified strength.
   2. When concrete has been cured as specified for same length of time as age at test date of laboratory-cured cylinders which reached specified strength. Determine length of time concrete has been cured in structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of air in contact with concrete is above 50 DEGF and concrete has been damp or sealed from evaporation and loss of moisture.

END OF SECTION

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SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Reinforcing, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Testing of reinforcing steel welding shall be performed by Owner's testing agency at Owner's expense.
   1. Retests due to failed initial tests shall be paid by Contractor.

B. ASTM International (ASTM):
   1. ASTM A36 Standard Specification for Carbon Structural Steel
   2. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   3. ASTM A663 Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
   4. ASTM A675 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
   5. ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   6. ASTM A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
   7. ASTM A884 Standard Specification for Epoxy-Coated Wire and Welded Wire Reinforcement.
   8. ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

C. American Concrete Institute (ACI):
   1. ACI 315 Details and Detailing Concrete Reinforcement.

D. American National Standards Institute (ANSI) /American Welding Society (AWS):
   1. ANSI/AWS-D1.4 Structural Welding Code- Reinforcing Steel.

E. California Administrative Code (CAC).

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. For each type of material and accessory.

C. Shop Drawings:
   1. Shop drawings indicating size, number, dimensions and locations of reinforcing steel and accessories, in sufficient detail to permit installation of reinforcing without reference to Contract drawings.
      a. Details of concrete reinforcement and accessories not indicated on Contract Documents shall be in accordance with ACI 315.

D. Project Information:
   1. Certification that reinforcing to be welded conforms to ASTM A706.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. End Bearing Splice Couplers:
   1. Base:
      a. Erico Products.

B. Tension Splice Couplers:
   1. Base:
      a. Erico Products.
      b. Dayton Metal Products.
      c. Dextra America Inc.

C. Epoxy Adhesive for Anchoring Reinforcing:
   1. Base:
      a. HIT System by Hilti.

D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. General Reinforcing:
   1. Conform to ASTM A615, Grade-60.

B. Welded Reinforcing:
   1. Conform to ASTM A706.

C. Welded Wire Reinforcement:
   1. Smooth wire flat sheets.
   2. Conforming to ASTM A1064 and to wire size and spacing as indicated on Drawings.

D. Smooth Dowel Bars for Construction Joints:
   1. Conform to ASTM A663 or ASTM A675, Grade-60.
   2. Where indicated, provide a metal dowel cap at one end of dowel to permit longitudinal movement of dowel within concrete section.
   3. Provide for movement which equals joint width plus 1/2 IN.
   4. Unless otherwise indicated, use 5/8 IN diameter dowels spaced 18 IN on center.

E. Slab on Grade Plate Dowels:
   1. ASTM A36 steel.
   2. May be used as an equal substitute for smooth dowel bars at construction joints.
   3. Diamond Dowel System, by PNA Construction Technologies, size 1/4 IN x 4-1/2 IN dowels or equal .
   4. Locate plate dowels per smooth dowel bar requirements.
   5. Do not shear plates.
   6. Remove burrs at edges of plates.

F. End Bearing Splice Couplers:
   1. Erico Speed-Sleeve Splice by Erico Products.

G. Tension Splice Couplers:
   1. Minimum 125 PCT yield strength of bar.
   2. Where drawings indicate tension splice couplers, provide one of following:
      a. Lenton threaded tension coupler by Erico Products.
      b. Bar-Grip tension coupler by Dayton Metal Products.
      c. Cadweld tension splice by Erico Products.
      d. Bar-Lock lockshear bolt coupling sleeves by Dayton Superior
      e. Barte Mechanical Couplers by Dextra America, Inc.

H. Epoxy Coating for Reinforcing:
   1. Conform to ASTM A775.
   2. Coat reinforcing specifically noted on Drawings in addition to splice couplers.
   3. Touch up damaged coating areas in field.

I. Epoxy Anchored Reinforcing:
   1. Install reinforcing anchored in concrete with epoxy adhesive, in accordance with epoxy manufacturer's instructions.

2.3 FABRICATION

A. Bars for Concrete Reinforcement:
   1. Sheared length: Plus or minus 1 IN.
   2. Depth of truss bars: Plus 0, minus 1/2 IN.
   3. Overall dimensions of stirrups, ties, and spirals: Plus or minus 1/2 IN.
   4. Other bends: Plus or minus 1 IN.

B. Bars with End Bearing Splice Couplers:
   1. Terminate bar ends in flat surfaces within 1-1/2 DEG of right angle to axis of bars.
   2. Fit within 3 DEG of full bearing after assembly.

PART 3 - EXECUTION

3.1 WELDING

A. Perform welding of reinforcing steel in conformance with AWS-D1.4.

B. Use E70 electrodes.

C. Each welder shall place an approved identifying mark near each completed weld.

D. Cut out welds determined to be defective.
   1. Weld and retest at Contractor's expense.

3.2 PLACING REINFORCEMENT

A. Provide minimum concrete covering for reinforcement as follows:
   1. Concrete deposited against earth: 3 IN.
   2. Formed surfaces exposed to weather or in contact with earth:
      a. 2 IN for reinforcing bars No.6 or larger.
      b. 1-1/2 IN for reinforcing bars less than No.6.
   3. Interior surfaces:
      a. 1-1/2 IN for beams, girders, and columns.
      b. 3/4 IN for slabs, walls and joists with No.11 bars or smaller, and 1-1/2 IN with No.14 and No.18 bars.

B. Place bars to following tolerances:
   1. Clear distance to formed surfaces: Plus or minus 1/4 IN.
   2. Minimum spacing between bars: Minus 1/4 IN.
   3. Top bars in slabs and beams:
      a. Members 8 IN deep or less: Plus or minus 1/4 IN.
      b. Members between 8 and 24 IN deep: Plus/minus 1/2 IN.
      c. Members more than 2 FT deep: Plus or minus 1 IN.
   4. Crosswise of members: Spaced evenly within 2 IN.
   5. Lengthwise of members: Plus or minus 2 IN.

C. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
   1. If moved more than one bar diameter, or enough to exceed above tolerances, resulting arrangement of bars subject to approval.

D. Assure that reinforcement, at time concrete is placed, is free of materials that may adversely affect or reduce bond.
   1. Reinforcement with rust, mill scale or a combination of both is acceptable provided dimensions and weights, including heights of deformations, of a cleaned sample is not less than required by ASTM.

E. Support reinforcement and fasten together to prevent displacement by construction loads or placing of concrete beyond tolerances indicated.
   1. On ground, provide supporting concrete blocks or other approved method.
   2. Over formwork, use concrete, metal, plastic or other approved bar chairs and spacers.
   3. Where concrete surface will be exposed to weather in finished structure, furnish accessories within 1/2 IN of concrete surface of non-corrosive material or protect against corrosion.

F. Overlap welded wire reinforcement not less than spacing of cross wires plus 2 IN.
   1. Unless shown otherwise, support welded wire reinforcement by methods of Paragraph E, above.

G. Offset vertical bars in columns at least one bar diameter at lapped splices to ensure proper placement, furnish templates for column vertical bars and dowels.

H. Splices not specifically indicated shall be subject to approval.

I. Unless permitted by Architect/Engineer, do not bend reinforcement after embedding in hardened concrete.

J. Unless permitted by Architect/Engineer, do not tack weld reinforcing.

END OF SECTION

SECTION 03 31 00
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Materials and Proportioning, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
1. ASTM C33 Standard Specification for Concrete Aggregates
2. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
3. ASTM C94 Standard Specification for Ready-Mixed Concrete
4. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
5. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
6. ASTM C150 Standard Specification for Portland Cement
7. ASTM C157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
8. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
9. ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
10. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
11. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
12. ASTM C311 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
13. ASTM C330 Standard Specification for Lightweight Aggregates for Structural Concrete
14. ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
15. ASTM C567 Standard Test Method for Determining Density of Structural Lightweight Concrete
16. ASTM C595 Standard Specification for Blended Hydraulic Cements
17. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
18. ASTM C989 Standard Specification for Slag Cement for Use in Concrete and Mortars
19. ASTM C1399 Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
20. ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

B. American Concrete Institute (ACI):
1. Comply with applicable provisions of following ACI publications, latest edition, except as otherwise indicated.
2. ACI 301 Specifications for Structural Concrete for Buildings.

C. Concrete Mixture Proportioning:
1. Employ and pay for testing agency acceptable to Architect and Owner to perform materials evaluation, testing and design of concrete mixes.

2. Certificates, signed by material producer and Contractor, may be submitted in lieu of material testing when approved by Architect.

D. Concrete Testing:
   1. Specified in Section 03 08 13
   2. Contractor to assist with related communication and temporary storage of test cylinders at jobsite.

E. Preinstallation Conference:
   1. See Section 01 31 19.
   2. Minimum thirty-five (35) days prior to start of concrete construction schedule, conduct meeting to discuss approved mix designs and required methods and procedures to achieve required concrete construction.
   3. Send a Pre-Installation Conference agenda to attendees twenty (20) days prior to scheduled date of the conference.
   4. Invite responsible representatives, in addition to those listed in Section 01 31 19, including but not limited to following:
      a. Ready-mix concrete producer.
      b. Admixture manufacturer.
      c. Concrete pumping equipment manufacturer
      d. Laboratory responsible for the concrete design mix.
      e. Owners Testing Agency responsible for field quality control.
   5. Record minutes of the meeting and distribute to attendees within five (5) days of conference.
      a. Include statement by concrete contractor indicating proposed mix design, and placing, finishing and curing procedures produce concrete quality required by specifications.

1.3 SUBMITTALS

A. Product Data:
   1. Concrete Mix Designs:
      a. Submit each Mix Design individually.
      b. Do not combine multiple mix designs into a single submittal.
      c. Submit following data for each concrete mix proposed:
         1) Intended use.
         2) Proportions of materials.
         3) Slump.
         4) Air content.
         5) 7-day and 28-day compression test results of trial mixes or those used for standard deviation analysis of an established mix.
            a) Test records for use in standard deviation analysis must have been made within 24 months of the date of the submittal and represent a time span of production of not less than 45 days.
      d. Submit source and certification or proof of quality (and compatibility of admixtures) for each of the constituents of the proposed concrete mixes. Compatibility of admixture must be certified.
         1) Cement.
         2) Aggregate.
         3) Water.
         4) Admixtures:
            a) Air Entraining Admixture.
            b) High-Range Water Reducer.
            c) Other.
      e. Submit concrete mix designs using the mix design submittal form included at the end of this specification.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lightweight Concrete:
   1. Concrete made with low density, lightweight aggregate ASTM C 330 or mixture of lightweight and normal weight aggregate.
   2. Concrete having a density between 90 PCF and 115 PCF.

B. Normal Weight Concrete:
   1. Concrete for which density is not a controlled attribute.
   2. Materials used in production must be of same quality, properties and proportion as indicated in approved concrete mix design as approved by Architect.

C. Under-slab Vapor Retarder:
   1. Specified in Section 03 31 10.

D. Cement:
   1. Portland cement conforming to ASTM C150 or blended cements conforming to ASTM C595.
   2. Color: Natural gray.

E. Aggregates:
   1. General:
      a. Regard fine and coarse aggregates as separate ingredients.
      b. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to grading requirements of applicable ASTM specifications.
   2. Normal Weight Concrete:
      a. ASTM C33, also aggregate shall be obtained from a source approved by the State Highway Department for use in concrete for state bridges.

F. Potable Water:
   1. Conforming to ASTM C1602.

G. Admixtures:
   1. Use only when specifically required or permitted by Contract Documents, otherwise must be approved by Architect.
   2. Trial mixes and tests shall be prepared with job materials, including admixture, to demonstrate that there will be no subsequent reduction in strength or durability of hardened concrete.
   3. Provide admixtures certified by manufacture to be compatible with other admixtures. Calcium chloride, thiocyanates, and admixtures containing more than 0.05 PCT chloride ions are not permitted.
   4. Air-entraining Admixtures: ASTM C260.
   5. Mid-Range Water Reducer: ASTM C494, Type A.
   6. High-Range Water Reducer :
      a. ASTM C494, Type F or G. Subject to complying with these specifications, the following manufacturers of High Range Water Reducing Admixtures are approved:
         1) Daracem – 100 or Adva Flow Seriesby Grace Construction Products.
         2) MasterRheobuild 1000 , MasterGlenium Series or PS 1466 by BASF Master Builders Solutions.
         3) Eucon 37 , Eucon SPJ or Plastol Series by Euclid Chemical.
         4) PSP-N, PSP-N2, PSP-R, and PSP-L by Procrete Industries.
      b. Other manufacturers desiring approval comply with Section 01630.
   7. Water-reducing, Retarding, and Accelerating Admixtures: ASTM C494.
   8. Non-Chloride, Non-Corrosive Accelerating Admixture:
      a. ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration)

using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products include:
1) Euclid Chemical Co; Accelguard (The) 80, 90 or NCA . www.euclidchemical.com
2) BASF; Masterset AC 534. www.buildingsystems.basf.com
3) W.R. Grace & Co; Daraset. www.na.graceconstruction.com

b. Other manufacturers desiring approval comply with Section 01630.

9. Viscosity Modifying Admixture (VMA):
   a. Specialty admixture to reduce bleed and segregation in concrete
      1) Euclid Chemical Company (The); Visctrol.
      2) Boral Materials Technologies; Boral SL.
      3) BASF; MasterMatrix VMA Series
   b. Other manufacturers desiring approval comply with Section 01630.
10. Calcium-nitrite Corrosion Inhibitor:
   a. Base Products: DCI and DCI S by Grace Construction Products.
   b. Rheocrete CNI by BASF Master Builders Solutions.
   c. Eucon CIA by the Euclid Chemical Company
11. Supplementary Cementitious Materials:
   a. Fly ash - ASTM C618, Class C or Class F.
      1) Samples shall be obtained, prepared, and tested in accordance with ASTM C311.
   b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
12. Synthetic Macro Fibers
   a. ASTM C1116 Type III
   b. Where permitted, fiber reinforced concrete shall replace and provide equivalent reinforcing to that indicated in both direct tension and bending capacity for concrete thickness indicated
   c. Testing per ASTM C1018 and/or ASTM C1399 shall indicate a minimum residual strength of 170 PSI. Establish dosage rate required to meet performance specified.
      1) Submit manufacturers data verifying conformance
   d. Minimum Dosage rate 4 LBS/CU YD.
   e. Acceptable manufacturers
      1) W.R.Grace Co,; Strux 90/40
      2) Euclid Chemical Company Tuf-Strand SF

2.2 PROPORTIONING CONCRETE MIXES

A. General:
   1. Contractor and concrete supplier are responsible to provide concrete, in-place, which satisfies requirements listed in following table.
   2. Contractor and concrete supplier are responsible to adjust the concrete mixes, as needed, to:
      a. Correct for non-conformance.
      b. Correct for a variation in the quality of a constituent.
      c. Compensate for extreme conditions in the field.

B. Establish concrete material proportions by any of the proportioning methods described in AC1-301 guidelines.

Concrete Properties Table – IP Units

Use	28-day strength (KSI)	Dry Unit Weight (PCF)	Max Aggregate. Size (IN)	Air percent	Max. W/C Ratio	Slump (IN)	Cement type
Footings	4.0		1-1/2	4.5	0.48		I
Walls	4.0		1	4.5	0.48		I
Slabs-on-grade	4.0		1 1/2		0.53		I
Structural floors, girders, slabs, columns	4.0		3/4		0.45		I

Concrete Properties Table – IP Units							
Use	**28-day strength (KSI)**	**Dry Unit Weight (PCF)**	**Max Aggregate. Size (IN)**	**Air percent**	**Max. W/C Ratio**	**Slump (IN)**	**Cement type**
Lt. Wt. Slabs, beams, girders	4.0	112	3/4		0.57		I
All other uses	4.0		3/4	6	0.48		I

C. Instructions for use of Table:
1. Provide concrete mixes with properties indicated in locations identified in Use column.
2. 28-day Strength:
   a. Installed concrete must meet or exceed the minimum 28-day compressive strength indicated.
   b. Laboratory mix design strengths must exceed this strength by the appropriate amount per AC1-301.
   c. Determine strength in accordance with ASTM C192 and ASTM C39.
3. Dry Unit Weight:
   a. If no value is listed, assume normal weight.
   b. Dry unit weight of light weight mixes shall be maximum air dry unit weight permitted.
   c. Correlate fresh weight with air dry weight of same mix to use as basis of acceptance on job site. Test in accordance with ASTM C567 and ASTM C138.
   d. Dry unit weight for concrete for Radiation Shielding shall be minimum air dry unit weight permitted. Use heavy aggregate if necessary.
4. Maximum Aggregate Size:
   a. Maximum size of coarse aggregate determined in accordance with:
      1) ASTM C33 for normal weight concrete.
   b. Some mixes are designated 3/4 IN or 1 IN, permitting contractor option.
5. Air Content:
   a. Required percentage of entrained and entrapped air as measured by ASTM C231, ASTM C173, or ASTM C138, as appropriate.
   b. Tolerance of air content as delivered is +/- 1-1/2 PCT for normal weight and +/- 2 PCT for lightweight concrete.
   c. When left blank, the required air content is not specified. All concrete exposed to freezing and thawing shall have air content between 4.5 PCT and 7.5 PCT. All interior slabs and all slabs to receive dry shake shall have a maximum air content of 3 PCT.
6. Water Reducer:
   a. Mid Range Water Reducer or High Range Water Reducer shall be provided as necessary to achieve slump indicated.
   b. Contractor, as option, may elect to use Water Reducers to improve workability or permit pumping.
7. Maximum W/C Ratio:
   a. Maximum ratio of pounds of water allowed to pounds of cementitious material used in the concrete mix.
8. Slump:
   a. Mixes without Water Reducers:
      1) Slump tolerance: Up to 1 IN above maximum indicated is allowed, provided the average of 5 consecutive batches does not exceed the indicated amount by more than a 1/2 IN.
   b. Mixes with Water Reducers:
      1) Slump indicated is after dosing.
      2) Slump tolerance after dosing: +1-1/2 IN and -1 IN is permitted for each batch.
   c. Determine slump in accordance with ASTM C143.
   d. Where slump is not specified, provide concrete with slump in accordance with approved mix designs.

9. Cement:
   a. Type: Provide cement type indicated.
   b. As option, the contractor/supplier may use Fly Ash or Ground Blast Furnace Slag for partial replacement of cement.
      1) For each unit of cement that is removed, replace with two units of Class F Fly Ash or one unit of Class C Fly Ash.
      2) For each unit of cement that is removed, replace with one unit of Ground Blast Furnace Slag.
      3) Maximum amount of cement replaced shall not exceed that specified in table 4.2.2.7.b.2 of ACI 301
      4) W/C ratio shall be based on total cementitious material content

D. Admixtures:
   1. Use admixtures in accordance with manufacturer's instructions.
   2. Use only approved admixtures.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

A. Store cement in weather tight buildings, bins, or silos which will exclude moisture and contaminants.

B. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
   1. Perform tests for determining conformance to requirements for cleanliness and grading on samples secured from aggregates at point of batching.
   2. Do not use frozen or partially frozen aggregates.

C. Allow sand to drain until it has reached relatively uniform moisture content before use.

D. Store admixtures in manner to avoid contamination, evaporation, or damage.
   1. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure uniform distribution of ingredients.
   2. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics.

3.2 MIXING AND DELIVERY

A. Batch, mix and transport concrete in accordance with ASTM C94.

B. Batch and mix admixtures in accordance with manufacturer's instructions.

C. Water added to concrete at the job site:
   1. Water additions at job site shall be limited to comply with W/C Ratio requirements.
   2. Do not allow water to be added to the mix unless the amount allowed is clearly indicated on the truck delivery ticket.

D. Following addition of High Range Water Reducer, mix for a minimum of 70 revolutions or 5 minutes to assure a consistent mixture.

E. Reduction of required average strength:
   1. During construction, and after sufficient data becomes available, laboratory strength of mixes may be reduced in accordance with Section 3.11 of AC1-301, subject to approval by the Architect.

END OF SECTION

CONCRETE MIX DESIGN SUBMITTAL FORM

Project: _____

City: _____

General Contractor: _____

Concrete Contractor: _____

Concrete Strength (Class): _____

Use - describe: _____

Design Mix Information:

	Check one
Based on Standard Deviation Analysis:	
Trial Mix Test Data:	

Design Characteristics:

Density: _____ PCF
Strength: _____ PSI (28 day)
Air: _____ Percent specified

Materials:

Materials	Type/Source	Specific Gravity	Weight/lb.	Absolute Vol. CU FT
Cement				
Fly Ash				
Slag				
Coarse Aggregate				
Fine Aggregate				
Water				
Air				
Other				
		TOTAL		**27.0 CU FT**

* Water/Cementitious Ratio (lbs, water/lbs. cement) = _____ Percent

Admixtures:

Admixtures	Manufacturer	Dosage 0Z/CWT
Water Reducer		
Air Entraining Agent		
High Range Water Reducer		
Non-Corrosive Accelerator		
Color Pigment		
Other		

Slump before HRWR _____ Inches
Slump after HRWR _____ Inches

Standard Deviation Analysis (from experience records):

Number of Test Cylinders Evaluated: _____

Standard Deviation: _____

Use the larger value:

f'cr = f 'c + 1.34s or f 'cr = f 'c + 2.33s – 500 for 5000 PSI or less

f 'cr = 0.90 f 'c + 2.33s for higher strengths

(Refer to ACI 301 for increased deviation factor when less than 30 tests are available)

Laboratory Test Data:

Compressive Strength			
Age - Days	Mix No.1 - PSI	Mix No.2 - PSI	Mix No.3 - PSI
7			
7			
28			
28			
28 average			

F'cr = f'c + 1200 PSI for 5000 PSI or less
Or 1.10 f'c + 700 PSI for strengths higher than 5000 PSI at 28 days

Required Attachments:

	Check
Combined Aggregate Gradation Report	
Standard Deviation Analysis of Compressive Strength Data or Trial Mixture Test Data	
Admixture Compatibility Certification Letter	

Submitted by: _____

Name: _____

Address: _____

City, State, Zip Code _____

Phone Number: _____

Main Plant Location: _____

Miles from Project: _____

Secondary Plant Location: _____

Miles from Project: _____

Date: _____

END OF SUBMITTAL FORM

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SECTION 03 31 10
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Mixing, Placing, Jointing and Curing as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
1. ASTM C94 Standard Specification for Ready-mixed Concrete.
2. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
3. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
4. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
5. ASTM C567 Standard Test Method for Determining the Density of Structural Lightweight Concrete.
6. ASTM D1751 Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
7. ASTM D1752 Standard specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
8. ASTM E1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
9. ASTM E1745 Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

B. American Concrete Institute (ACI):
1. ACI 302.1R Guide for Concrete Floor and Slab Construction
2. ACI 305.1 Hot Weather Concreting.
3. ACI 306.1 Cold Weather Concreting.

1.3 SUBMITTALS

A. Shop Drawings:
1. Placement plans: Indicate proposed locations of construction joints and placement sequence.
2. Screeding and finishing plan.

B. Product Data:
1. Vapor Retarder.

C. Project Information:
1. Joint filler technical data.
2. Strippable Curing compound technical data.
   a. Interior slabs:
      1) Include floor covering manufacturer's written approval for use.
      2) Include procedures to be used for removing compound
3. Waterstop technical data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Evaporation Retarder
   1. Base:
      a. Euclid Chemical Company (The); Eucobar.
   2. Optional:
      a. BASF; MasterKure ER50.

B. Strippable Curing Compound:
   1. Base:
      a. Kurez DR VOX or Kurez W VOX by Euclid Chemical Company.
      b. L&M Cure R by L&M Construction Chemicals
      c. Clear Resin Cure J11W by Dayton Superior
      d. 1150 Clear by WR Meadows
      e. SpecRez by SpecChem, LLC

C. Curing Sheet Material
   1. Base
      a. Hydracure M5 by PNA Construction Technologies, Inc.
   2. Optional:
      a. Transguard 4000 by Reef Industries, Incorporated

D. Self-Expanding Rubber Strip Waterstops:
   1. Base:
      a. Greenstreak by Sika
   2. Optional:
      a. Adcor by Grace Construction Products
      b. Adeka by OCM, Inc.

E. Vapor Retarders: As noted.

F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Concrete Materials and Proportioning: See Section 03 31 00.

B. Premolded Expansion Joint Filler: Type required, conforming to ASTM D1751 or ASTM D1752.

C. Evaporation Retarder
   1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete designed to inhibit the loss of moisture before and during the finishing process.

D. Curing Sheet Material:
   1. Provide where concrete is scheduled to be stained.
   2. Moisture-Retaining Cover Conforming to ASTM C171: Naturally colored, non-woven polypropylene fabric with a 4-mil non-perforated reflective (white) polyethylene coating.
   3. Fabric shall exhibit low permeability and high moisture retention.

E. Strippable Curing Compound:
   1. Conform to ASTM C309 with VOC no greater than 350 g/l.
   2. Where used on slabs receiving subsequent applied finishes, compound must be removed completely after curing.
   3. Install in accordance with manufacturer's recommendation and supervision.

F. Underslab Vapor Retarder:
   1. Meet ASTM E1745 Class A.

2. Maximum Water Vapor Permeance: 0.01 Perms.
3. Minimum Tensile Strength, ASTM E154: 55 FT-LB/IN.
4. Minimum Puncture resistance: 2,200 grams, minimum.
5. Base Product:
   a. Perminator - 15 MIL by WR Meadows.
6. Optional Products:
   a. Barrier-Bac VB350 - 16 MIL by Inteplast.
   b. Moistop Ultra - 15 MIL by Fortifiber.
   c. Stego Wrap - 15 MIL by Stego Industries.
   d. Vapor Block Plus - 20 MIL by Raven Engineered Films.
   e. Viper VaporCheck II - 15 MIL by ISI Building Products.
   f. Yellow Guard – 15 mil by Poly-America.
7. Tape as recommended by vapor retarder manufacturer.
8. Other manufacturers desiring approval comply with requirements of Section 01630.

G. Waterstops:
   1. Self-Expanding Rubber Strip Waterstops:
      a. Bentonite-free hydrophilic polymer modified chloroprene rubber, suitable for adhesive bonding to concrete.
      b. Profile: Rectangular or trapezoidal strip unless otherwise indicated.
      c. Minimum Dimensions: 3/8 IN by 3/4 IN thick.
      d. Provide in maximum practicable length to minimize end joints.
      e. Butt splice joints at intersections and at ends of pieces in accordance with manufacturer's instructions.
         1) Make joints to develop effective water tightness fully equal to that of continuous waterstop material, to permanently develop not less than 50 PCT of mechanical strength of parent section, and permanently retain flexibility.

PART 3 - EXECUTION

3.1 MIXING AND PRODUCTION OF CONCRETE

A. Batch, mix and transport ready-mixed concrete in accordance with ASTM C94.
   1. Plant equipment and facilities shall conform to Check List for Certification of Ready Mixed Concrete Production Facilities of National Ready Mixed Concrete Association.

B. Site batched and mixed concrete will be permitted only after ability to control quality has been demonstrated to satisfaction of Architect.

3.2 MIXING - CONTROL OF ADMIXTURES

A. Incorporate admixtures in accordance with Manufacturers recommendations.

B. Verify compatibility with manufacturers when more than one admixture is used.

3.3 MIXING - LIGHTWEIGHT CONCRETE

A. Batch and mix lightweight aggregate concrete as recommended by producer of aggregate.
   1. Contact Architect for review and approval of procedures at variance with specified values.

B. If lightweight aggregate absorbs less than 2 PCT water by weight within 1 HR, batch and mix concrete based on test of a sample from field conditioned supply.

C. If absorption exceeds 2 PCT, batch and mix concrete as follows:
   1. Add aggregate to approximately 80 PCT of mixing water and mix for a minimum of 1-1/2 minutes (15 revolutions in a truck mixer).
   2. Then add admixtures, entire weight of cement, and withheld portion of mixing water in order named, and mix.

D. Base acceptance of lightweight concrete in field on fresh unit weight measured in accordance ASTM C138.
   1. Nominal fresh unit weight shall be that corresponding to specified maximum air-dry unit weight calculated from formula in ASTM C567.
   2. When nominal fresh unit weight varies more than 2 PCF from required weight, adjust mixture as promptly as conditions will permit to bring unit weight to desired level.
   3. Do not allow fresh unit weight of batch to vary more than 3 PCF from desired level.

3.4 MIXING - TEMPERING AND CONTROL OF MIXING WATER

A. Mix concrete only in quantities for immediate use. Discard concrete which has set.

B. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded.
   1. Incorporate water by additional mixing equal to at least half of total mixing required.
   2. Do not add water after discharge commences

3.5 MIXING - WEATHER CONDITIONS

A. Cold Weather:
   1. Comply with ACI 306.
   2. In cold weather, temperature of concrete when delivered at site shall conform to following limitations:
   3. For sections with least dimension greater than 36 IN, comply with table 3.1 of ACI 306R

Minimum Concrete Temperature Required at Time of Pour		
Air Temperature at time of pour	For sections with least dimension less than 12 IN	For sections with least dimension 12 IN to 36 IN
Above 30 DEGF	60 DEGF	55 DEGF
0 to 30 DEGF	65 DEGF	60 DEGF
Below 0 DEGF	70 DEGF	65 DEGF

Minimum Concrete Temperature Required within 24 Hours of Pour		
Air Temp within 24 Hours of pour	For sections with least dimension less than 12 IN	For sections with least dimension 12 IN or greater
Below 32	60 DEGF	50 DEGF

   4. If water or aggregate is heated above 100 DEGF, combine water with aggregate in mixer before cement is added.
      a. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 DEGF.
      b. Final temperature of combined mix shall not exceed 90 DEGF or be high enough to cause flash set or loss of slump or workability.

B. Hot Weather:
   1. Comply with ACI 305 when high temperature, low slump, flash set, or cold joints are encountered.
   2. Cool ingredients before mixing, or add flake ice or well-crushed ice of a size that will melt completely during mixing for all or part of mixing water. Account for water contribution by ice when calculating the quantity if mixing water and insure that specified W/C ratio is not exceeded.

3.6 PREPARATION BEFORE PLACING

A. Equipment:

1. Remove hardened concrete and foreign material from inner surfaces of conveying equipment.
2. Provide spare vibrator on job site during concrete placing operations.
3. In cold weather, have protective blankets ready and heaters operational and in-place before placing concrete.

B. Forms:
1. Complete formwork: Remove frost, snow, ice, water and foreign material; secure reinforcement in place, position expansion joint material, anchors, and other embedded items and have entire preparation inspected prior to concrete placement.
2. In hot weather when temperature of reinforcing or forms is greater than 120 DEGF spray forms and reinforcement with water just prior to placing concrete.

C. Screeds and Screed Rails:
1. Develop a screed system to accurately strike off fresh concrete to the surfaces and elevations defined on drawings.
2. Anticipate deflection of formwork and support systems.
   a. Provide and place extra concrete as necessary to produce finish surfaces with specified tolerances at designated elevations and contours at no additional cost to the Owner.
3. When form work is cambered whether shored or un-shored and screeding is performed perpendicular (i.e., up and over) to crown of camber set screed rails to follow camber and provide a slab of uniform thickness.
   a. When screeding parallel with the camber, set one screed at midspan along crown of camber and one along girder or support.
   b. Two passes of the screed is necessary to cover one full bay.
4. Other screeding methods may be used provided deflection of un-shored formwork is taken into consideration.
5. On unshored steel framing systems, accurately strike off concrete using a laser to produce a level surface after steel supporting system has deflected due to dead weight of fresh concrete. Anticipate steel framing deflection to be 0 inch at columns, and up to 1 1/2 inches at mid-point of bays, with an approximately parabolic profile.
6. Slab thickness on cambered steel shall not be less than that indicated on plan.
7. If not required in documents and subjected to approval of Architect, Contractor as option may camber formwork.
8. Concrete shall be struck off with a vibrating screed.
9. Use of a wet screed system will not be permitted unless:
   a. Concrete is struck with a pneumatically vibrated floater screed.
   b. A highway straight edge is used to true the surface perpendicular to direction of screeding.
   c. A satisfactory finish is produced on a trial slab.
10. Submit a screeding and finishing plan for approval.
    a. A representative trial slab pour shall be provided to demonstrate that the specified tolerances and a satisfactory surface can be provided by the proposed method of screeding and finishing.

D. Subgrade for Slabs on Grade:
1. Subgrade shall be well drained and of adequate and uniform load bearing nature.
   a. Keep in-place density of subgrade soils at least to minimum indicated.
2. Keep subgrade free of frost before concrete placing begins.
   a. If temperature inside a building where concrete is to be placed is below freezing, raise temperature and maintain above 50 DEGF long enough to remove frost from subgrade and reinforcing.
3. Keep subgrade moist at time of concreting.
   a. If necessary, dampen with water in advance of concreting.
   b. Allow no free water standing on subgrade nor muddy or soft spots when concrete is placed.

3.7 UNDER-SLAB VAPOR RETARDER

A. Place continuous vapor retarder over granular fill.
   1. Installation as recommended by manufacturer.

B. Comply with ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
   1. Lap vapor retarder at ends and edges of sheets and seal with vapor retarder tape.
   2. Extend to extremities of area.
   3. Turn up at perimeter walls to form bond breaker and tape in place.
   4. Terminate at top of foundation or grade beam for slabs on grade.
   5. Detail sleeved or drilled penetrations as recommended by manufacturer.
      a. Coordinate detailing at penetrations with subcontractors responsible for penetrations.

C. Protect vapor retarder. Repair punctures, tears and other damage using vapor retarder tape.

D. Trim excess material after slab is placed.

E. Inspect and approve vapor retarder installation prior to concrete placement.
   1. See Section 01 45 20.

3.8 PROTECTION

A. Unless adequate protection is provided and approval is obtained, do not place concrete when temperature is below freezing or during rain, sleet or snow.

B. Do not allow rainwater to increase mixing water nor to damage surface finish.

C. Concrete damaged by rain or weather and judged defective by Architect shall be removed and replaced by Contractor at no additional cost to Owner or corrected by procedures listed in Section 03 08 13.

3.9 CONVEYING

A. Handle concrete from mixer to place of final deposit as rapidly as practicable by methods which prevent segregation or loss of ingredients and assure that quality is maintained.

B. Use equipment conforming to ASTM C94.

C. Use horizontal belt conveyors or mount at a slope which will not cause excessive segregation or loss of ingredients.
   1. Protect concrete against undue drying or rise in temperature.
   2. Handle to prevent segregation.
   3. Do not allow mortar to adhere to belt.
   4. Discharge long runs into a hopper or through a baffle.

D. Use metal or metal-lined chutes with slope between 1 vertical and 2-3 horizontal.
   1. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.

E. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity.
   1. Control pneumatic placement so that segregation is not apparent in discharged concrete.
   2. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 IN.
   3. Do not convey concrete through pipe made of aluminum or aluminum alloy.

3.10 DEPOSITING IN FORMS

A. Work Includes:
   1. Deposit concrete continuously or in layers of such thickness that no concrete is deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section.
   2. Place at such a rate that concrete which is being integrated with fresh concrete is still plastic.

3. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
4. Remove temporary spreaders in forms when concrete placing has reached an elevation rendering their service unnecessary.
5. Temporary spreaders may remain embedded in concrete only if made of metal or concrete and if prior approval has been obtained.

B. Do not start placing concrete in supported elements until concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.

C. Deposit concrete as nearly as practicable in its final position to avoid segregation due to re-handling or flowing.
1. Do not subject concrete to procedure which will cause segregation.
2. Concrete shall not drop more than 6 FT unless approved by the Architect/Engineer. For greater heights, provide special mix design, chute, spout, tremie, or other approved method.

D. Concrete buckets shall be equipped with rubber discharge tubes.
1. Tube size shall be effective in directing flow of concrete directly downward between reinforcing.
2. Unless it can be demonstrated, no segregation will occur with greater distances, maximum free fall distance of concrete below flexible tube is limited to 4 FT.

E. Consolidation:
1. Consolidate concrete by vibration, so that concrete is thoroughly worked around reinforcement, around embedded items and into corners of forms eliminating air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. Use internal vibrators having a minimum frequency of 8000 vibrations per minute to consolidate concrete effectively.
3. Do not use vibrators to transport concrete within forms.
4. Insert vibrators and withdraw at points approximately 18 IN apart.
5. At each insertion allow duration sufficient to consolidate concrete but not sufficient to cause segregation; generally from 5 to 15 sec.
6. Where concrete is to have an as-cast finish, bring a full surface of mortar against form by vibration process, supplemented if necessary by spading, to work coarse aggregate back from formed surface.

3.11 SLAB PLACEMENT

A. Coordinate mixing and placing with finishing.
1. Do not place concrete on subgrade or forms more rapidly than it can be spread, straight edged, and darbied or bull floated.
2. Perform these operations before bleed water has an opportunity to collect on surface.

B. Plan size of finishing crews to achieve good surfaces and avoid cold joints caused by temperature and atmospheric conditions.
1. If construction joints become necessary, construct as required under joints and embedded items.

C. Consolidation:
1. Thoroughly consolidate concrete in slabs.
2. Use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade.
3. Obtain consolidation of slabs with vibrating screeds, roller pipe screeds, internal vibrators, or other approved means.

3.12 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - Other than Slab on Grade:
1. Locate joints not indicated so as to least impair strength of structure.
a. Place joints in locations approved by Architect/Engineer.

2. In general, locate near middle of spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice width of beam.
   a. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
   b. Place beams, girders, brackets, column capitals, haunches, and drop panels at same time as slabs.
   c. Make joints perpendicular to main reinforcement.
3. Continue reinforcement across joints.
4. Clean surface of concrete at joints thoroughly and remove laitance.
   a. Prior to placing adjoining concrete, dampen, but do not saturate, hardened concrete of construction joints.

B. Joints – Slabs on Grade:
   1. Construction joints:
      a. Place keyed dowelled or diamond plate construction joints as indicated on plans and at locations where a slab placement is terminated or interrupted.
      b. Size of placements and sequence of slab placement is Contractor's option, except construction joints shall be located at a control joint location.
      c. Construction joints act as control joints.
   2. Control joints:
      a. Provide contraction (control) joints as indicated.
      b. If not shown, provide along column centerlines.
      c. Where column centerline spacing or spacing between column centerlines and walls exceeds 20 FT, provide an intermediate joint at intervals not exceeding 20 FT.
      d. Locate joints to produce panels that are as square as possible with length not exceeding 1.5 times width.
      e. Also provide joints where change in slab width occurs, such as at block-outs, pits, etc.
      f. If saw cut joints are required or permitted, time cutting properly with set of concrete by one of the following methods:
         1) A conventional saw, cutting as soon as possible after final finishing when cutting action will not tear, ravel, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Cut to a depth of 1/4 slab thickness or 1/3 slab thickness if steel-fiber or structural synthetic macro fiber reinforcement is used.
         2) An early entry saw beginning immediately after final finishing when cutting action will not tear, ravel, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
            a) Remove debris in path of cut and under skid plate before cutting. Skid plate must remain flat on surface.
            b) Use early entry saw blades and skid plates.
            c) Install early entry joint protector at saw-cut intersection prior to cross-cut.
            d) Remove dry powder without disturbing finish.
            e) Avoid traffic across saw cut until sufficient strength is gained to protect joint edges.
   3. Complete before shrinkage stresses become sufficient to produce cracking.
   4. Isolation joints:
      a. Provide isolation joints around columns, and between slab on grade and walls.
      b. Also provide isolation joints around equipment or machinery isolation pads, pits, pipes, etc., unless detailed otherwise.

C. Expansion Joints:
   1. Do not permit reinforcement or other embedded metal items bonded to concrete, except dowels in floors bonded on only one side of joints, to extend continuously through expansion joint.
   2. Locate expansion joints as indicated.

D. Acoustic Isolation Joint:
1. Do not permit any reinforcing or other bonded items to extend through joint.
2. Remove forming material and clean joint thoroughly prior to cover installation. Locate as indicated.

E. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to placement of concrete.
1. Give Contractors whose work is related to concrete or supported by it ample notice and opportunity to introduce and/or furnish embedded items before concrete placement.
2. Position expansion joint material, waterstops, and other embedded items accurately and support against displacement.
3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete.

3.13 BONDED JOINTS

A. At construction joints indicated as bonded, obtain bond by one of following methods:
1. Roughen surface of concrete in an approved manner which will expose aggregate uniformly and not leave laitance, loosened particles of aggregate or damaged concrete at surface.
a. Dampen (but do not saturate) hardened concrete of joints in exposed work; joints in middle of beams, girders, joists, and slabs; and joints in work designed to contain liquids.
b. Thoroughly cover with a coat of cement grout of similar proportions to mortar in concrete.
c. Use grout as thick as possible on vertical surfaces and at least 1/2 IN thick on horizontal surfaces.
d. Place fresh concrete before grout has attained its initial set.
2. Prepare joints receiving an adhesive and apply adhesive in accordance with manufacturer's recommendations prior to placing of fresh concrete.
3. Prepare surfaces of joints which have been treated with a chemical retarder in accordance with manufacturer's recommendations prior to placing of fresh concrete.

3.14 SLAB FINISHING

A. See Section 03 35 00.

3.15 CURING AND PROTECTION

A. Work Includes:
1. Beginning immediately after placement, protect concrete from premature drying, hot or cold temperatures, and mechanical injury, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration and hardening of concrete.
2. Materials and methods of curing subject to approval.

B. Preservation of Moisture:
1. Preserve moisture in slab before and during finishing until slab is ready for application of final curing.
2. When conditions warrant, apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 LB/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions one or more times after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Final curing:
1. Interior slabs:
a. Application of sheet curing materials.
b. Application of strippable curing compound.
1) Submit written approval from floor covering manufacturer prior to use.

2) Apply in accord with recommendations of manufacturer immediately after water sheen, which may develop after finishing, has disappeared.
3) Apply continuous film at manufacturer's specified rate.
4) Completely remove prior to application of floor covering material.

2. Other concrete surfaces not in contact with forms apply one of following procedures immediately after completion of placement and finishing:
   a. Ponding or continuous sprinkling.
   b. Application of absorptive mats or fabric kept continuously wet.
   c. Application of sand kept continuously wet.
   d. Continuous application of mist spray, not exceeding 150 DEGF.
   e. Application of sheet curing materials.
   f. Application of other moisture-retaining covering as approved.
   g. Application of strippable curing compound.
      1) Apply in accordance with recommendations of manufacturer immediately after water sheen has disappeared.
      2) Apply continuous film at manufacturer's specified rate.
      3) Remove after curing where cured surface is against which additional concrete or other material is to be bonded, unless it is proven that curing compound will not prevent bond.
3. Minimize moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by sun by keeping forms wet until they can be safely removed.
   a. After form removal cure concrete until end of time prescribed.
4. Continue curing in accordance with ACI 301 and ACI 302. Seven days for most concrete.
   a. If tests made of cylinders, kept adjacent to structure and cured by same methods, indicate average compressive strength has reached 70 PCT of specified strength, (f'c), moisture retention methods may be terminated.
   b. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is 1 day old, provided concrete is not permitted to become surface dry during transition.

D. Temperature, Wind and Humidity:
1. Cold weather:
   a. When mean daily outdoor temperature is less than 40 DEGF maintain temperature of concrete between 50 and 70 DEGF for required curing period.
   b. When necessary make arrangements for heating, covering, insulating, or housing concrete work adequate to maintain required temperature without injury.
   c. Do not use combustion heaters during first 24 HRS unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
2. Hot weather:
   a. When necessary make provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   b. Take such protective measures as quickly as concrete hardening and finishing operations will allow.
3. Rate of temperature change:
   a. Keep changes in temperature of air immediately adjacent to concrete during and immediately following curing period as uniform as possible.
   b. Do not exceed 5 DEGF in any 1 HR or 50 DEGF in any 24-hour period.

E. Protection from Mechanical Injury:
1. During curing period, protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
3. Do not load self-supporting structures in such a way as to overstress concrete.

F. Protection of Slabs on Grade from Frost:

1. Interior slabs exposed to freezing temperatures shall be adequately protected so that frost does not develop in supporting subgrade.

3.16 ELEVATOR DOOR FRAMES

A. Elevator Door Frames in Concrete Shafts:
   1. Block-out as required by Elevator Manufacturer to allow for door frames to be set.
   2. After door frames have been set, set forms across void between frame and edge of block-out.
   3. Fill in with concrete fill.

END OF SECTION

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SECTION 03 35 00
CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Finishing and Repair of Surface Defects, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. ASTM E1155 Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
   2. ACI 302.1R Guide for Concrete Floor and Slab Construction

B. Floor Finish Tolerances:
   1. Follow F-Number System as defined in ASTM E1155.
      a. Floor Flatness F-Number: F_F defines maximum floor curvature allowed over 24 IN computed on basis of successive 12 IN elevation differentials.
      b. Floor Levelness F-Number: F_L defines relative conformity of floor surface to a horizontal plane measured over a 10 FT distance.
      c. Above number pair to be stated in form: F_F/F_L.
      d. Specified Overall Value (SOV) is enumerated and is based on composite of measured values in a placement.
      e. Minimum Local Value (MLV) describes flatness or levelness below which repair or replacement is required. MLV is based on individual placement and applies to minimum local area not crossing construction or control joints.

C. Trial Concrete Panels:
   1. Provide trial panels to permit evaluation of finishing properties and appearance of concrete proposed for use.
   2. Panels size: 8 x 8 FT, of specified thickness, and made with specified materials and proportions, using equipment and personnel comparable to those employed on work.
   3. Demonstrate concrete capable of being finished at a slump not exceeding that specified.
   4. Construct panels and secure approval prior to proceeding with finish in specified location.
   5. Approved panels shall serve as standards by which corresponding finishes in structure will be accepted or rejected.
   6. Construct panels at approved location, not as part of structure. Protect from construction operations, weather, and damage until acceptance of completed concrete work. Remove from site when directed.
      a. Provide one 4 IN thick approved panel for each slab finish specified. Panel shall be on grade.
      b. Provide one 4 IN thick approved panel for smooth form finish. Panel shall be vertical.
      c. Provide one 4 IN thick approved panel for each rubbed finish specified. Panel shall be vertical.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Chemical Hardener:
   1. Base:

a. BASF Master Builders Solutions.
2. Optional:
a. SpecChem, LLC

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Bonding Agent:
1. Approximately 1 part Portland cement to 1 part fine sand passing a No.30 mesh sieve.
2. Mix to consistency of thick cream.

B. Patching Compound:
1. Same materials and approximately same proportions as used for concrete, except omit coarse aggregate.
2. Shall consist of not more than 1 part Portland cement to 2-1/2 parts sand by loose volume.
3. For exposed concrete, part of Portland cement shall be white to produce a color matching color of surrounding concrete, as determined by a trial patch.
4. Add no more water than necessary for handling and placing.
5. Mix compound in advance and allow to stand with frequent manipulation, without addition of water, until it has reached stiffest consistency that will permit placing.

C. Grout Mix:
1. Cleaned rubbed finish:
a. Mix 1 part Portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout with a consistency of thick paint.
2. Cork floated rubbed finish:
a. Mix 1 part Portland cement and 1 part fine sand with sufficient water to produce a stiff grout.

D. Proprietary Materials:
1. Contractor's option: Proprietary compounds for adhesion, patching, or finishing may be used in lieu of or in addition to foregoing grouts.
2. Use such compounds in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 FINISHING

A. After removal of forms, repair and give surfaces of concrete finishes indicated.
1. Top surface of slabs not included.

B. Unspecified finish: If finish is not designated, use following finishes as applicable:
1. Unpainted concrete surfaces not exposed to public view: Rough form finish.
2. Unpainted concrete surfaces exposed to public view: Smooth form finish.
3. Concrete surfaces to receive paint: Grout cleaned rubbed finish.
4. Unformed surfaces (except slabs): As indicated.

3.2 REPAIR OF SURFACE DEFECTS

A. Repair surface defects immediately after form removal.

B. Remove honeycombed and other defective concrete down to sound concrete.

C. Chip if necessary to make edges perpendicular to surface or slightly undercut.

D. No feather edges will be permitted.

E. Dampen area to be patched and an area at least 6 IN wide surrounding it to prevent absorption of water from patching compound.

F. After surface water has evaporated from area to be patched, brush bonding agent into surface.

G. When bonding agent begins to lose water sheen, apply patching compound.

H. Thoroughly consolidate compound into place and strike off so as to leave patch slightly higher than surrounding surface.

I. To permit initial shrinkage, leave undisturbed for at least 1 HR before final finish. Keep patched area damp for 7 days.

J. Do not use metal tools in finishing a patch which will be exposed.

K. Tie holes:
1. Unless stainless steel, non-corrosive, or acceptably coated ties are used, tie holes shall be filled.
2. Clean and thoroughly dampen tie holes; fill solid with patching compound.

3.3 AS-CAST FINISHES

A. Rough Form Finish:
1. No selected form facing materials are specified for rough form finish surfaces.
2. Concrete surfaces shall conform to tolerances in f 03 11 00 Concrete Formwork.
3. Patch defects and tie holes.
4. Chip or rub off fins exceeding 1/4 IN in height.
5. Leave surfaces with texture imparted by forms.

B. Smooth Form Finish:
1. Use form facing material to produce a smooth, hard, uniform texture on concrete.
2. Arrange facing material orderly and symmetrical, with number of seams kept to practical minimum.
3. Support by studs or other backing capable of preventing excessive deflection.
4. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.
5. Patch tie holes and defects.
6. Remove fins completely.
7. When surface textures are impaired and form joints misaligned by more than 1/8 IN grind bush hammer, or otherwise correct affected concrete.
8. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
9. Repair major mortar leakage as a defective area.

C. Unformed Surface Finish:
1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float to a texture reasonably consistent with that of formed surfaces.
3. Continue final treatment on formed surfaces uniformly across unformed surfaces.
4. Not intended for slabs.

3.4 RUBBED FINISHES

A. General:
1. Form and repair concrete surfaces to receive rubbed finishes, in accordance with requirements for smooth form finish.
2. Remove forms and perform necessary patching as soon after placement as possible without jeopardizing structure.

B. Smooth:
1. Produce smooth rubbed finish on newly hardened concrete no later than day following form removal.
2. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
3. Use no cement grout other than cement paste drawn from concrete itself by rubbing process.

C. Grout Cleaned:

1. Undertake no cleaning operations until contiguous surfaces are completed and accessible.
2. Wet surface of concrete sufficiently to prevent absorption of water from grout and apply grout uniformly.
3. Immediately after applying grout, scrub surface vigorously with a cork float or stone to coat surface and fill air bubbles and holes.
4. While grout is still plastic, remove excess grout by working surface with a rubber float, sack, or other means.
5. After surface whitens from drying, rub vigorously with clean burlap.
6. Keep finish damp for at least 36 HRS after final rubbing.

D. Cork Floated:
1. Remove forms at an early stage, within 2 to 3 days of placement where possible.
2. Remove ties.
3. Remove burrs and fins.
4. Dampen wall surface.
5. Apply grout with firm rubber float or with trowel, filling surface voids.
6. Compress grout into voids.
7. If grout surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with a fog sprayer.
8. Produce final texture with a cork float using a swirling motion.

3.5 SLAB FINISHING

A. General:
1. Place slabs to finish tolerances specified.
2. Slab finish: Use following finishes at building locations noted.
   a. Scratched finish: Surfaces intended to receive bonded applied cementitious applications, such as setting beds, grout, etc.
   b. Floated finish (magnesium):
      1) Surfaces intended to receive roofing, waterproofing membranes, or sand bed terrazzo.
      2) Surfaces of ramps, docks, stairs in which no other covering is specified.
   c. Broom or Belt finish: Parking garage floors.
   d. Troweled finish:
      1) Floors intended as walking surfaces or to receive floor coverings.
      2) Roof surfaces intended to receive protected membrane roofing system.
   e. Non-slip finish (interior and exterior): Ramps, docks, stairs specifically noted on drawings.

B. Finishing tolerances:
1. For shored construction, measurements for conformance with finishing tolerances shall be made as soon as slab can tolerate foot traffic, and before shores are removed.
2. The F_L levelness tolerance is not applicable to unshored form work such as cast in place topping on prestressed tees, slabs on unshored steel and metal deck, or unshored, post-tensioned slabs on steel beams.
3. Horizontal finishes will be accepted provided:
   a. Applicable specification requirements are satisfied.
   b. Water does not pond in areas sloped to drain.
   c. Floor finish tolerances F_F/ F_L conforms to that specified for particular finish and Minimum Local Values are not less than 75 percent of the floor finish tolerance specified.
4. Accumulated deviation from intended true plane of finished surface does not exceed 1 IN.
5. Accuracy of floor finish does not adversely affect installation and operation of movable equipment, floor supported items or items fitted to floor.

C. Finishes:
1. Scratched finish:

a. After concrete has been placed, consolidated, struck off, and leveled to a F_F15/ F_L13 tolerance, roughen surface with stiff brushes or rakes before final set.

2. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating.
   b. Using a magnesium float, begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operation.
   c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
   d. Cut down high spots and fill low spots during this procedure to produce a surface within F_F20/ F_L15 tolerance throughout.
   e. Refloat slab immediately to a uniform sandy texture.
3. Troweled finish:
   a. Sequence:
      1) Float finish
      2) Power trowel
      3) Hand trowel
   b. First troweling after power floating shall produce a smooth surface which is relatively free of defects but which may still indicate some trowel marks.
   c. Final trowel when a ringing sound is produced as trowel is moved over surface.
   d. Thoroughly consolidate surface by hand troweling.
   e. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to F_F25/ F_L20 tolerance.
   f. On surfaces intended to receive floor coverings, grind off defects which would indicate through floor covering.
   g. On surfaces intended to receive waterproofing membranes grind off defects that might tear or otherwise damage membrane.
4. Broom or belt finish:
   a. Immediately after concrete has received float finish, give it a coarse scored texture by drawing a broom or burlap belt across surface transverse to slope or traffic flow.
5. Non-slip slab finish:
   a. Aggregate: Crushed, ceramic bonded aluminum oxide particles. Apply at 25 LB per 100 SQFT.
   b. Blend aggregate with Portland cement in proportions recommended by manufacturer of aggregate.
   c. Give surface a float finish.
   d. Apply approximately two-thirds of blended material for required coverage to surface by a method that ensures even coverage without segregation.
      1) Begin floating immediately.
   e. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application.
   f. Make second application heavier in areas not sufficiently covered by first application. Follow with second floating immediately.
   g. After selected material has been embedded by two floatings, complete operation with a broomed finish.

END OF SECTION

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SECTION 05 05 05
GALVANIC CORROSION PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Galvanic Corrosion Protection, as indicated, in accordance with provisions of Contract Documents.

B. Use information in this Section to coordinate, select and apply products listed in other Sections for purposes of Galvanic Corrosion Protection.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
1. ASTM STP576 Galvanic and Pitting Corrosion - Field and Laboratory Studies
2. ASTM G82 Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. Architectural Sheet Metal Manual – Appendix C

1.3 GALVANIC CORROSION POTENTIAL

A. Galvanic Scale: Less Noble, anodic metals are electropositive and corrode more readily. Noble cathodic metals are electronegative and less likely to corrode.

Galvanic Scale
Anodic / Corroded End / Less Noble Materials
Zinc
Aluminum
Galvanized Steel
Cadmium
Mild Steel / Wrought Iron
Cast Iron
Stainless Steel, Types 304 & 316 (active)
Lead-tin Solder
Lead
Brass / Bronze
Copper
Stainless Steel, Types 304 & 316 (Passive)
Cathodic / Protected End / Noble Materials

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Avoid contact between metals farther apart on scale.

B. Do not couple a small exposed area of a more noble material with a large area of a less noble material.

C. Coat noble metal with a suitable paint or other nonmetallic coating or coat both surfaces at interface with zinc chromate or bituminous coating.

D. Separate metals by tape, gasket, waterproof paper, elastomeric sheet, sealant or other nonabsorptive, nonconductive material.

E. Do not allow moisture runoff from noble material to drain onto less noble material.

F. Do not use copper nails for fastening galvanized steel roof panels.

G. Do not use galvanized steel nails on copper roofing.

H. Do not use galvanized bolts, nuts or washers on stainless steel components.

3.2 METALS EMBEDDED IN CONCRETE

A. Hot dip galvanized with bituminous paint.
   1. Use at exterior and interior areas exposed to weather or high humidity.

B. No galvanized steel with bituminous paint:
   1. Use at interior areas with low or ordinary humidity.
   2. Avoid direct embedment where exposed to weather or high humidity.

END OF SECTION

SECTION 05 12 10
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Structural Steel, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Structural steel work covered herein shall be fabrication and erection of steel framing and bracing members including connections and steel material either supporting or connected to steel members shown on structural plans and not specified in other Sections.

B. Quality standards latest edition of following standards plus any corresponding published revisions at time of bidding shall be applicable standard. The Local Building Code shall govern if conflicting.
1. Local Building Code.
2. American Institute of Steel Construction (AISC):
   a. ANSI/AISC 360 “Specification for Structural Steel Buildings” (referred to herein as the AISC Specification).
   b. Code of Standard Practice for Steel Buildings and Bridges (referred to as AISC Code of Standard Practice).
   c. Quality Certification Program.
3. American Welding Society:
   a. Structural Welding Code - Steel ANSI/AWS-D1.1 (referred to herein as the AWS Code). AWS Code shall govern techniques and quality of welding and testing procedures. Statements contained in the AWS Code requiring information to Bidders and/or Contract Documents to define nondestructive testing or statements defining responsibilities and obligations for services and payment shall be disregarded.
4. Research Council on Structural Connections: “Specifications for Structural Joints Using High Strength Bolts” (referred to herein as RCSC Specification).
5. Steel Structures Painting Council (SSPC): Steel Structures Painting Manual Vol. 2, “System and Specifications”, referred to herein as SSPC Specification.

C. Fabricator Qualifications:
1. Certified by AISC Quality Certification Program for Structural Steel Fabricators and is designated as AISC Certified Fabricator, Standard for Steel Building Structures.
2. Fabricators not certified shall have minimum ten (10) years experience and shall employ an approved testing agency to inspect fabrication work performed off site.
3. Testing agency shall furnish weekly inspection reports and a final report to Building Official and Architect certifying work was performed in accordance with specifications and approved shop drawings.

D. Erector Qualifications:
1. Minimum 10 years experience in erection of structural steel.
2. Certified as Certified Steel Erector by AISC quality Certification Program.
3. Certification by other equivalent programs subject to approval of the Structural Engineer.

E. Source Quality Control:
1. Provide access and facilities for testing agency during shop and field inspections.

F. Testing and Inspection: Testing, (except testing to qualify welders and as needed for Contractor's own quality control), will be performed at no cost to Contractor by a Testing/Inspection Agency employed by Owner. Owner's Testing/Inspection Agency may use nondestructive testing methods in addition to visual inspection to verify weld quality. Repair rejected welds as directed by Testing/ Inspection Agency at no additional cost to Owner.

G. Provide testing and inspection agency with sufficient notification and access so that inspection and testing can be accomplished.

H. Previous acceptance of material or finished members by testing and inspection agency or Architect/Engineer shall not prevent its rejection at later date if it does not comply with specifications.

I. Tolerances:
1. Rolling: ASTM-A6.
2. Fabrication and Erection tolerances: AISC Code of Standard Practice.

J. Complete final detailing of connections where details provided do not adequately reflect conditions.
1. Connection arrangement and detail shall be consistent with details provided on Contract Documents.
2. When applicable, use tables provided in AISC for selection. Arrangements shall match type and strength of connection detail provided.
3. Identify in submittal connections that do not conform to details provided in contract documents.
4. Final arrangement and details of connections subject to review and approval of Structural Engineer Of Record

1.3 SUBMITTALS

A. Shop Drawings:
1. Indicate details including cuts, copes, connections, holes and welds. Indicate shop and field welds using AWS symbols. Indicate connections where high strength bolts are required.
2. Headed stud placement drawings.

B. Product Data:
1. Source and certification of quality for high-strength bolts, nuts and washers.
2. Technical data on base plate grout.

C. Project Information:
1. Fabricator's AISC Certification or name of independent testing agency for use by non-certified fabricator along with proof that fabricator has 10 years experience in fabrication of structural steel for buildings.
2. Inspection reports and certification of shop fabrication by independent testing laboratory for non-certified fabricator.
3. Steel erector's AISC Certification or proof that steel erector has 10 years experience in erection of structural steel.
4. Welding Procedure Specification (WPS) for shop and field welds.

D. Contract closeout information:
1. Certificate by fabricator that steel was fabricated in accordance with the approved construction documents.
2. Certificate by erector that steel was erected in accordance with the approved erection plans and specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel, Structural W-Shapes and Tee's:
   1. ASTM A992 (50 ksi yield point).

B. Steel, Structural Angles and Channels:
   1. ASTM A36.

C. Steel plate
   1. ASTM A572 (50 ksi yield point)

D. Pipe, Round:
   1. ASTM A53, Grade-B.

E. Tubing, Round, Square, or Rectangular:
   1. ASTM A500, Grade-C. (50 ksi yield point for square or rectangular; 46 ksi yield point for round)

F. Bolts, Nuts, and Washers, High Strength.
   1. Conform to RCSC Specification.
   2. Twist off style, conform to ASTM F1852
      a. Approved bolts:
         1) Tension control bolt by LeJeune Bolt Company, Burnsville, MN.
         2) Tru-Tension Fasteners by Nucor Fastener a Division of Nucor Corporation, St. Joe, Indiana.
         3) Lohr Fasteners by Lohr Structural Fasteners, Humble, TX.

G. Bolts, Nuts and Washers, Standard Strength:
   1. Bolts: ASTM A307, Type A.
   2. Nuts: ASTM A563.
   3. Washers plain: ANSI/ASME-B18.22.1.

H. Anchor Bolts, High Strength:
   1. Bolts or rod for threading: ASTM F1554-105 ksi. meeting supplementary requirement S4. Pretension to load indicated on plans.
   2. Nuts, heavy hex: ASTM-A563.
      a. Up to 1 1/2 IN diameter: Grade D hex
      b. Over 1-1/2 IN diameter: grade DH Heavy Hex.
   3. Washers:
      a. Hardened Steel: ASTM F436 type 1
      b. Load indicator type: Direct Tension Indicating Washers as manufactured by TurnaSure LLC of Langhorne, PA or approved equal, Install per manufacturers recommendations
   4. Thread tolerance: ANSI/ASME-B18.1, Class 2A.

I. Anchor Bolts, Standard Strength:
   1. Bolts or rod for threading: ASTM A36 or ASTM F1554-36 ksi.
   2. Nuts and washers:
      a. Nuts: ASTM A563.
      b. Washers plain: ANSI/ASME-B18.22.1.
   3. Thread tolerance: ANSI/ASME-B18.1, Class 2A.

J. Welding Electrodes:
   1. Shielded metal-arc: AWS A5.1 or AWS A5.5, E70XX
   2. .Submerged-arc: AWS A5.17 or A5.23, F7X-EXXX.
   3. Gas metal-arc: AWS A5.18, ER70S-X.
   4. Flux cored-arc: AWS A5.20, E70T-X (except 2, 3, 10, GS).

K. Headed Studs and Deformed Bar Anchors:

1. Headed studs (HS)
   a. Fabricated form cold drawn bar stock conforming to ASTM A 108, grades 1010 through 1020.
   b. AWS D1.1 type B.
   c. Minimum Yield strength: 51 ksi.
   d. Minimum tensile strength: 65 ksi over 3/8 IN diameter.
   e. Minimum tensile strength: 55 ksi 3/8 IN diameter and under.
2. Deformed bar anchors (DBA): Straight, unless otherwise indicated.
   a. ASTM A496.
   b. Minimum yield strength: 70 ksi.
   c. Minimum tensile strength: 80 ksi.

L. Grout: Pourable.
   1. Base: L&M Construction Chemicals, Duragrout.
   2. Minimum Strength : 4000 PSI at 7 days and 8000 PSI at 28 days.

M. Expansion Anchors:
   1. Expansion anchors shall be a single-end expansion shield anchor which complies with the descriptive part of Federal Specification FF-S325, Group II, Type 4, Class 1 for concrete expansion anchors. Anchors shall be Hilti Kwik Bolt TZ Expansion anchor by Hilti fastening systems of Tulsa, OK (ICC Report No. ESR-1917) or equal.

N. Adhesive Anchors:
   1. Threaded rods, bolts, etc., indicated as adhesive anchors into concrete or solid masonry:
      a. HIT HY-150 MAX - SD adhesive by Hilti Fastening Systems of Tulsa, OK (ICC Report No. ESR-3013) or equal.
      b. Unless indicated otherwise, adhesive anchor bolt shall conform to HAS - E Standard ISO Class 5.8 by Hilti or equal. Do not field cut rods without engineer's approval.

O. Slide Bearings at Expansion Joints:
   1. Masticord with teflon slide plates as manufactured by JVI MC., Skokie Illinois, or equal. Size, thickness, and configuration as shown on the drawings.

2.2 FABRICATION

A. General:
   1. Fabricate and assemble material in shop to greatest extent possible.
   2. Use A325 bolts, twist-off type, unless otherwise indicated.
   3. One sided or other types of eccentric connections not indicated, will not be permitted without prior approval.
   4. Bevels for field welds may be flame cut provided such cutting is done automatically. Leave free of burrs and slag.
   5. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
   6. Flame cut edges of stiffener plates at field or shop butt welds. Do not shear.
   7. Accurately mill bearing ends of columns.
   8. Trusses, beams and girders over 50 FT in length shall be cambered in an amount required by the Architect. Members less than 50 FT in length shall be cambered when indicated on the drawings or otherwise fabricate such that after erection any natural camber due to rolling or assembly is upward.
   9. Cut, drill, or punch holes at right angles to surface of metal.
      a. Do not make or enlarge holes by burning.
      b. Make holes clean cut, without torn or ragged edges.
      c. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
      d. Provide holes in members to permit connection of work of other trades.
   10. Make allowance for draw in of tension bracing.
   11. Make splices only as indicated.

12. Headed stud type shear connectors (H.S.) and deformed bar anchors (D.B.A.), on Drawings: Automatically end welded in accordance with AWS Code.
    a. When headed stud type shear connectors are to be either shop or field applied, clean top surface of beam flanges in shop to remove oil, scale, rust, dirt and other materials injurious to satisfactory welding.
    b. Fillet welding of headed studs and deformed anchors is not allowed without prior approval.
    c. Do not weld studs when temperature is below 0 DEGF or surface is wet with rain or snow.
    d. After welding, remove ceramic ferrules and maintain clean and free from substances which would interfere with function as anchor or bond of deformed anchor bars.
    e. Quality control: Weld minimum of 2 studs at start of each production period to determine proper generator, control unit, and stud welder settings.
        1) These studs shall be capable of being bent 45 DEG from vertical without weld failure. These studs shall not be included as a part of the required construction.
        2) All production studs shall be sounded by a sharp blow with a hammer.
        3) If, after welding, a stud does not ring when struck by a hammer or visual inspection reveals that sound weld or full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with hammer and bent approximately 15 DEG off perpendicular to nearest end of beam.
        4) Studs meeting this test shall be considered acceptable and shall be left in this position.
        5) Studs bent beyond 15 DEG shall be considered ineffective and replaced.
        6) Studs failing under this test shall be replaced.

B. Welding:
1. Welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work shall comply with AWS Code, and requirements indicated.
2. Test and qualify welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
    a. Conduct tests in presence of approved testing agency.
    b. Certification within last 12 months from a welding inspector will be acceptable provided samples of welder's work are satisfactory.
    c. At discretion of testing agency, shop personnel continuously employed at welding process for which they have been qualified may be accepted from older qualification tests.
3. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
4. Before start of welding work, meet with testing agency and welders to review and verify procedures.
5. Comply with AWS Code to minimize shrinkage and distortion stress.
6. Use back-up plates in accordance with AWS Code, extending minimum of 1 IN either side of joint.
7. Make flange welds before making web welds.
8. For manual shielded metal-arc welding: Comply with Article 4.6 of AWS Code.
9. Low hydrogen electrodes: Dry and store electrodes in compliance with AWS Code.
10. Do not perform welding when ambient temperature is lower than 0 DEGF, or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.
11. Before starting welding:
    a. Carefully plumb and align members.
    b. Fully tighten bolts.
    c. Assembly and surface preparation shall comply with AWS Code.
    d. Preheat base metal to temperature stated in AWS Code.
        1) When no preheat temperature is given and base metal is below 32 DEGF, preheat base metal to at least 70 DEGF.

2) Maintain temperature during welding.
3) Preheating shall bring surface of base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
4) Maintain this temperature during welding.

e. Each welder is to provide identifying mark at welds worked on.

2.3 SURFACE PREPARATION AND SHOP-APPLIED COATINGS

A. Surfaces Not to be Coated:
1. Do not coat following surfaces:
a. Surfaces to be fireproofed with spray-on material.
b. Machined surfaces, surfaces adjacent to field welds, contact surfaces of bolt connections where connection is specified as slip critical, and top of top flanges of beams.
c. Other members for which no coating is specified.
2. Clean thoroughly before shipping; remove loose mill scale, rust, dirt, oil and grease.

B. Hot Dip Galvanized (HDG) Members:
1. Galvanize following members:
a. Members set in, or in contact with, exterior surface material, including:
1) Brick ledge angles.
2) Embedded items in exterior surfaces.
b. Exterior exposed structure not indicated to be shop otherwise shop finished.
c. Other members indicated.
2. Clean thoroughly before galvanizing.
3. Galvanize in accordance with ASTM A123.

C. Exterior Surfaces to be Shop Primed for Finish Paint:
1. Primer: As recommended by finish (top) coat manufacturer for substrate.

D. Interior Surfaces to be Shop Primed for Finish Paint:
1. As recommended by top coat manufacturer for substrate.

PART 3 - EXECUTION

3.1 ERECTION

A. Safety:
1. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor.

B. Capacity of Partially Complete Construction:
1. Consider that full structural capacity of many structural members is not realized until structural assembly is complete; That is, until slabs, decks and diagonal braces are installed. Partially complete structural members shall not be loaded out of sequence without an investigation.
2. Until elements of the permanent lateral bracing system of the structure are complete, temporary lateral bracing for the partially complete structure will be required.

C. Temporary Bracing:
1. Provide adequate temporary bracing for stability and to resist loads to which the partially complete structure may be subjected including but not limited to, environmental conditions, construction activities and operation of equipment.
2. If not obvious from the drawings, confer with Architect to identify structural elements requiring completion before structure's permanent lateral bracing system is effective.

a. Design of temporary bracing system must consider sequence and schedule of placement of such elements and effects of loads imposed on structural steel frame by partially or completely installed work of other trades.
b. Do not remove temporary bracing until the permanent lateral bracing system is effective.

D. General:
1. Set base and bearing plates accurately and grout immediately as indicated.
a. Use metal wedges, shims or setting nuts as required.
b. Pack grout solidly between plate and bearing surface.
2. Clean bearing and contact surfaces before assembly.

E. Install A325SC bolts with washers. Install and tighten in accordance with the RCSC Specifications or in accordance with manufacturer's instructions when twist-off bolts are used.

F. Use same requirements for field welding as for shop welding.

G. Do not use gas cutting to correct fabrication errors on major members.
1. Gas cutting on minor members may be permitted when members are not loaded, only after approval by Architect.

H. Tighten and leave in place erection bolts used in welded construction.

I. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1:20 with a plane normal to bolt axis.

J. After installation, touch up damaged or abraded areas of primed steel using same materials used for shop priming.
1. Clean field welds, bolted connections and abraded areas before touching up.

K. After installation, repair galvanized surfaces damaged or abraded using zinc rich paint in accordance with ASTM A780.
1. Surfaces to be repaired with paint containing zinc dust shall be clean, dry, and free of oil, grease, preexisting paint, corrosion, and rust.
2. Surfaces to be repaired shall be blast cleaned to the requirements of SPC SP10 (near white). Where circumstances do not allow blast or power tool cleaning to be used, then hand tools may be used. Cleaning shall meet the requirements of SSPC SP2 (removal of loose rust, mil scale, or paint to the degree specified by hand chipping, scraping, sanding and wire brushing)
3. If areas /surfaces to be repaired include welds, first remove weld flux residue and weld spatter by blasting, chipping, grinding, or power scaling.
4. Spray or brush apply the paints containing zinc dust to the prepared surfaces/areas. Apply the paint in accordance with the manufacturer's recommendations in a single application employing multiple passes to achieve a dry film thickness equal to the original zinc coating thickness.

END OF SECTION

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SECTION 05 31 23
METAL ROOF DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Metal Roof Decking, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   2. ASTM A1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

B. American Iron and Steel Institute (AISI):
   1. Specification for Design of Cold-Formed Steel Structural Members.

C. American Welding Society (AWS):
   1. ANSI/AWS D1.3 Structural Welding Code – Sheet Steel.

D. Steel Deck Institute (SDI):
   1. Steel Roof Decking Design Manual.

E. Qualify welding processes and operations in accordance with AWS Standard Qualification Procedure.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Complete layout indicating types of deck panels, anchorage, supplementary framing, cut openings, accessories, and thicknesses.

B. Product Data:
   1. Manufacturer's load tables for deck to be furnished on this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Base:
   1. Vulcraft.

B. Optional:
   1. ASC Steel Deck.
   2. Consolidated Systems, Metal Dek Group,
   3. Canam United Steel Deck.
   4. Verco Decking.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Metal roof decking:
   1. Rib type, sheet steel, 18 GA minimum, with minimum uncoated thickness of 0.045 IN.

2. Fy= 33 KSI, Structural Steel.
3. Galvanized decking: ASTM A653, G60 zinc coating.
4. Painted decking: ASTM A1008, Grade-C.

B. Welding rod: E-60XX or greater in accordance with AWS D1.3

C. Mechanical Fasteners:
1. Corrosion-resistant, low-velocity fasteners.
   a. Powder actuated:
      1) Base:
         a) Hilti Inc., steel deck fastener.
   b. Pneumatically driven:
      1) Base:
         a) Pneutek, Inc.
   c. Self drilling, self threading screws:
      1) Hexagonal washer head; carbon-steel screws, No. 10 diameter min size.
      2) Base:
         a) Hilti, Inc
      3) Optional:
         a) Elco Textron
         b) Buildex
   d. Other manufacturers desiring approval comply with Section 01630.

D. Steel shapes, miscellaneous: ASTM A36.

E. Galvanizing for metal accessories: ASTM A653, G60.

F. Galvanizing repair paint: High zinc dust content paint, Mil-P-21035 ships.

G. Metal closure strips: Galvanized sheet steel, minimum 0.034 IN thick before coating, ASTM A653, G60 galvanized. See Part 3 - Execution for locations.

2.3 FABRICATION

A. Form in lengths to span 3 or more support spacing, with flush, telescoped or nested 2 IN end laps.
1. Use deck configurations complying with SDI Basic Design Specifications and as indicated.

B. Form metal closure strips to configuration required to provide tight-fitting closures at open ends and sides of decking.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which deck units are to be installed for conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Start of installation constitutes acceptance of responsibility for correct installation and performance.

3.2 INSTALLATION

A. Do not overload supporting members.

B. Install roof deck units and accessories as indicated.

C. Do not start placement of roof deck units until supporting members are installed complete.

D. Place each deck unit on supporting structural frame, adjust to final position, accurately align with ends bearing on supporting members.
   1. Lap units at ends no less than 2 IN.
   2. Do not stretch or contract side-lap interlocks.
   3. Place deck units flat and square and secure to framing without warp or excessive deflection.
   4. Install deck ends over supporting frame with a minimum end bearing of 1-1/2 IN.

E. Plug weld sizes specified are effective fusion diameter of welds.
   1. Weld metal shall penetrate layers of deck material at ends laps and have good fusion to supporting members.

F. Remove and replace decking which is structurally weak or unsound or which has burn holes due to improper welding or which Architect declares defective.

G. Cut and fit roof units and accessories around other work projecting through or adjacent to roof decking.
   1. Make cutting and fitting neat, square and trim.
   2. Neatly and accurately install reinforcing at openings except:
      a. Circular openings less than 6 IN diameter.
      b. Rectangular openings having no side dimension greater than 6 IN.
   3. Reinforce openings between 6 IN and 12 IN with 20 GA flat steel sheet 12 IN greater in each dimension than opening. Place sheet around opening and fusion weld to top surface of deck at each corner and each side midway between each corner.
   4. For roof openings larger than 12 IN and at roof drains: Support deck edges as indicated on Drawings

H. Install metal closure strips for support of roof insulation.
   1. Provide where rib openings in top surface of roof decking occur adjacent to edge and openings.
   2. Weld closure strips into position.

I. Install metal closure strips at open uncovered ends and edges of roof decking, and in voids between decking and other construction.
   1. Weld into position to provide a complete decking installation.

3.3 FASTENING OF ROOF DECKING

A. Welded Connection Requirements:
   1. Fasten roof-deck panels to steel supporting members by arc spot welds 5/8 IN effective diameter or arc seam welds with an equal perimeter that is not less than 1-1/2 IN long.
      a. Weld Spacing:
         1) Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support.
         2) Space welds: 18 IN apart, maximum.
      b. Weld Washers: Install weld washers at each weld location.
   2. Side-Lap and Perimeter Edge Fastening:
      a. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 IN, and as follows:
      b. Mechanically fasten with self-drilling, No.10 diameter or larger, carbon-steel screws.
      c. Mechanically clinch or button punch.
      d. Fasten with a minimum of 1-1/2 IN -long welds.

B. Mechanical connection requirements
   1. Mechanical fasteners, powder actuated or pneumatically driven steel pins, may be used in lieu of welding indicated to fasten deck to supports.
      a. Locate mechanical fasteners and install according to manufacturer's written instructions and as specified below.

b. Pin size, spacing, and accessories:
   1) Pin diameter and length per manufacturer's instructions for numbers of layers, deck gage, and steel flange thickness at a given condition.
   2) Connect edge and interior ribs of deck units with a minimum of two pins per deck unit at each support.
      a) Space pins 18 IN apart, maximum.
      b) Space pins 12 IN apart in the field of roof and 6 IN apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.
      c) Space pins as indicated.
   3) Install steel washers or provide pins with integral washers at each pin location. Washer size per manufacturer requirements.

2. Side-Lap and Perimeter Edge Fastening:
   a. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 12 IN, and as follows:
   b. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   c. Mechanically clinch or button punch.

3.4 CLEANING

A. Wire brush, clean and paint scarred areas, welds and rust spots on top surfaces of decking units and supporting steel members.

B. Touch-up damaged galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

C. Touch-up shop painted surfaces with same paint used in shop, as recommended by deck manufacturer.

END OF SECTION

SECTION 05 40 00
COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Cold-Formed Metal Framing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic- and – Nonmetallic-Coated for Cold-Formed Framing Members.
   2. ASTM C1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories

B. American Iron and Steel Institute (AISI):
   1. AISI S200 Series North American Standards for Cold-Formed Steel Framing.

C. Provide Cold-Formed Metal Framing engineered to support dead, live, and lateral (wind or seismic) loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Complete building elevations defining framing member sizes, locations, and connection details.
      a. Show openings, edges and support conditions with respect to.
      b. Show openings, edges and support conditions field verified and coordinated with respect to location, physical requirements of items to be installed in or on exterior wall system.

B. Project Information:
   1. Structural calculations for Cold Formed Metal Framing indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cold-Formed Metal Framing:
   1. Base:
      a. Telling Industries
   2. Optional:
      a. California Expanded Metal Products Co.
      b. Custom Stud Inc.
      c. Marino\WARE
      d. MBA Metal Framing
      e. MRI Steel Framing LLC

f. The Steel Network
g. ClarkDietrich Building Systems

B. Galvanizing Repair Coating:
1. Base:
a. Tnemec
2. Optional:
a. ZRC Worldwide
b. Sherwin Williams

C. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Design Cold-Formed Metal Framing to satisfy requirements of applicable building codes as locally amended, but not less than loads shown in contract documents.
1. Design Exterior Soffits similarly.
2. Include anticipated dead and live with lateral, wind or seismic, loads where details indicate cladding, soffits or equipment weights are carried by stud wall system.

B. Limit lateral deflection of stud wall system due to wind or seismic as follows:

Maximum Allowable Deflection	
Exterior Finish Material	Deflection Limit
Marble, Granite and other Stone Veneers	L/720
Brick and Concrete Masonry Veneers	L/600
Portland Cement Plaster (Stucco)	L/360
Manufactured Stone Veneer, Adhered Stone Veneer, Thin Brick, Tile and similar Mortar-Set finishes.	L/360
Metal Panels, Curtain Walls, and other flexible wall finishes.	L/240

C. Select stud gauge and spacing as required for strength and to limit deflection due to applied loads.
1. Utilize properties of metal stud only.
2. Do not include contributions provided by wallboard or sheathing.
3. Design connections such that anticipated structural movements will not adversely affect system or cladding supported by system
a. Allow for vertical beam deflections of span/600.
b. Allow for lateral interstory drift of story height/400.
4. Design framing system to resist gravity loads and wind uplift at soffits.

2.3 MATERIALS

A. Exterior Studs:
1. Galvanized 33KSI steel studs, runner channels and track, bracing, and accessories, minimum G60 galvanized.
a. Revise thickness and minimum requirements if 50 KSI steel is used.
2. Stud depth:
a. As indicated on Drawings.
3. Span:
a. As indicated on Drawings.
4. Stud spacing:
a. Use closer spacing as needed to satisfy load deflection criteria.
b. 12 IN OC minimum.

c. 16 IN OC maximum.
5. Stud, runner and track thickness:
   a. Minimum: 43 mils (18 GA).
   b. Increase member thickness where needed to satisfy loading and deflection criteria.
6. Deep-leg runner flange:
   a. Minimum: 2 IN .
7. Headers:
   a. C-shapes used to form header beams
   b. Web depths and stiffened flanges as required.
   c. Thickness: As determined by engineering calculations for specific opening.
8. Runner fasteners:
   a. Power driven fasteners.
   b. Minimum 190 LB shear and bearing.

B. Galvanizing Repair Coating:
1. Tnemec Series 94-H20 Hydro-Zinc.
2. ZRC Worldwide, Galvilite 221.
3. Sherwin Williams Zinc Clad III HS 100.

C. Gypsum Sheathing:
1. See Section 06 16 43.

D. Exterior Joint Sealants:
1. See Section 07 92 13.

E. Metal Blocking:
1. C-shaped modified track runners.
   a. Roll-form from corrosion-resistant galvanized steel.
   b. Conform to ASTM C645.
2. Galvanized: ASTM A653, G40.
3. Backing height: 6 IN minimum.
4. Flange width: 1-1/4 IN minimum.
5. Thickness: 30 MIL (20 GA) minimum.
6. Base product: Drywall Track by Telling Industries.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrate for suitability to accept work.

B. Start of work constitutes acceptance of substrate and responsibility for performance.

3.2 ERECTION

A. Studs and Runners:
1. Align outside deep leg runner track accurately according to exterior wall layout.
2. Fasten 12 IN OC, or as needed to satisfy design criteria.
3. Position studs vertically in inside deep leg runners at required spacing.
4. Install minimum of two (2) studs each side of openings; use more if required to meet loadings.
5. Anchorage:
   a. Top:
      1) Allow 3/4 IN clearance between top of inside deep leg runner and outside deep leg runner.
      2) Do not fasten inside deep leg runner to outside deep leg runner.
      3) Fasten studs to inside deep leg runner.

b. Bottom:
   1) Anchor each stud at bottom to runners with two, 3/8 IN minimum, type S-12 pan head screws.

6. Where stud design is outside edge of floor slab, provide galvanized connectors designed for loading requirements and allow individual floor movement without affecting integrity of stud system.
7. Shop weld assemblies as required to meet design requirements.
8. Touch-up burned off or abraded galvanizing with galvanizing repair coating.

B. Openings:
   1. Install header, jamb, and sill framing system per approved engineering documents

C. Coordinate installation of wall blocking used to support wall-supported items with installation of Cold-Formed Metal Framing.

3.3 PROTECTION

A. Protect erected wall and openings with temporary covers until finish, roofing, flashing, and windows are installed.

END OF SECTION

SECTION 05 41 04
LOAD BEARING METAL STUD SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Load Bearing Metal Stud System, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic- and – Nonmetallic-Coated for Cold-Formed Framing Members.
   2. ASTM C1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories

B. American Iron and Steel Institute (AISI):
   1. AISI S200 Series North American Standards for Cold-Formed Steel Framing.

C. Provide Load Bearing Metal Stud System engineered to support dead, live, and lateral (wind or seismic) loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Drawings prepared by the manufacturer showing plans, sections, elevations, profiles and product component locations, including anchorage, bracing, accessories and finishes.
      a. Show connection details with screw types and locations, weld lengths and locations, and other fastener requirements.
      b. Coordinate size of openings and support requirements for items installed in openings, with Contractor.

B. Product Data:
   1. Manufacturer's product literature, data sheets and installation recommendations.
   2. Manufacturer's allowable load tables including section properties.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Load Bearing Metal Stud System:
   1. Base:
      a. Telling Industries.
   2. Optional:
      a. California Expanded Metal Products Co. (CEMCO).
      b. Custom Stud Inc.
      c. Marino/Ware.
      d. MBA Metal Framing
      e. MRI Steel Framing, LLC
      f. The Steel Network.

g. ClarkDietrich Building Systems.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Design Load Bearing Metal Stud System to support following vertical loads:
1. Uniform dead load: 20 PSF.
2. Live load: Either 20 PSF uniformly distributed, or a concentrated moving load of 500 LBS at any location, whichever is most restrictive.

B. Design Load Bearing Metal Stud System to resist a horizontally applied equal to 2 PCT of total supported load.
1. Utilize only structural properties of metal studs for calculating required member sizes, thickness, and spacing.
2. Do not include contribution of attached materials such as drywall or sheathing for design strength.
3. Define size, thickness and spacing of members to be used subject to following:
   a. Minimum Stud Width:
      1) 6 IN.
   b. Minimum material thickness:
      1) 16 GA.
   c. Maximum stud spacing: 16 IN OC.
      1) Where a wider spacing is required to accommodate access within crawl space, use double studs at jambs and double stud box beam at the track as required to maintain structural integrity of system.
   d. Increase above criteria as required to satisfy Design Loads.
4. Deck bearing requirements:
   a. Provide a minimum of 3 IN bearing surface for continuous deck spans.
   b. Provide a minimum of 1-1/2 IN bearing for non-continuous deck spans, (i.e. edge conditions).

2.3 MATERIALS

A. Metal Studs and Tracks:
1. Steel Quality:
   a. 16 GA and heavier: ASTM A1011 steel.
   b. 18 GA and lighter: ASTM A1008 steel.
2. Minimum Yield Strength: 33,000 PSI.
3. Finish:
   a. G60 galvanized.
   b. Prime with rust inhibitive, red oxide paint.
4. Stud sizes:
   a. As specified in Article 2.2.
5. Track Thickness: Not less than thickness required for studs.
   a. Exception: Thinner track gauges may be used where demonstrated by structural calculation to be acceptable.

B. Metal Stud System Accessories:
1. Clips and connectors.
2. Bridging, bracing, and backing systems.
3. Fire-Rated connectors.
4. Specialty clips, connectors, and fasteners as recommended by manufacturer.
5. Horizontal bracing at maximum 4 FT on center.
6. Diagonal strap bracing for in-plane lateral forces.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine supporting structure and conditions under which stud system will be installed.

B. Correct conditions detrimental to proper completion.

C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Install in accordance with stud system manufacturer's instructions.

B. Provide continuous top and bottom track sized to match studs.

C. Butt-weld top and bottom track at splices.

D. Weld stud flanges to top and bottom track.

E. Do not splice load-bearing studs.

F. Fasten headers or lintels by welding or bolting.

G. Touch-up damaged primed surfaces.

END OF SECTION

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SECTION 05 50 10
MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Miscellaneous Metal Fabrications, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
2. ASTM A36 Standard Specification for Carbon Structural Steel
3. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings
4. ASTM A48 Standard Specification for Gray Iron Castings
5. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
6. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
7. ASTM A148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
8. ASTM A197 Standard Specification for Cupola Malleable Iron
9. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
10. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
11. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
12. ASTM A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
13. ASTM A480 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
14. ASTM A484 Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
15. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
16. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
17. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
18. ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
19. ASTM A992 Standard Specification for Structural Steel Shapes
20. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings
21. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
22. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
23. ASTM B308 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

B. American Society of Mechanical Engineers (ASME):
1. ANSI/ASME-A17.1 Handbook on Safety Code for Elevators and Escalators

C. American Institute of Steel Construction (AISC)
   1. Steel Construction Manual

D. American Iron and Steel Institute (AISI):
   1. Specification for the Design of Cold-Formed Steel Structural Members.

E. American Welding Society (AWS):
   1. ANSI/AWS C1.1M/C1.1 Recommended Practices for Resistance Welding
   2. ANSI/AWS D1.1 Structural Welding Code - Steel.
   3. ANSI/AWS D1.3 Structural Welding Code - Sheet Steel.

F. National Association of Architectural Metals Manufacturers (NAAMM):
   1. Class 1, Architectural, per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.

G. Provide Miscellaneous Metals Fabrications engineered to support dead, live, and lateral (wind or seismic) loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Plans and elevations showing members and connections.
   2. Anchors and accessory items.

B. Project Information:
   1. Structural calculations for Miscellaneous Metals Fabrications indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.

C. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Materials Listed:
   1. Base: As noted.

B. Galvanizing Repair Paint:
   1. Base:
      a. Tnemec.
   2. Optional:
      a. ZRC Worldwide.
      b. Sherwin-Williams.

C. Shop Primer:
   1. Base:
      a. As recommended by finish coat manufacturer for substrate.
   2. Optional:
      a. Sherwin-Williams.
      b. Tnemec.

D. Non-shrink Grout:
   1. Base:
      a. Dayton Superior Corporation.

2. Optional:
   a. Sauereisen.
   b. CGM Building Products.

E. Decorative Bollard Covers:
1. Base:
   a. Innoplast.

F. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Structural Steel:
1. Structural W and T shapes: ASTM A992, 50KSI yield point.
2. Other steel shapes and plate: ASTM A36.
3. Pipe: ASTM A53 Grade B.
4. Tubing: ASTM A500, Grade B, 46KSI minimum.

B. Cast Steel:
1. ASTM A27, Grade-65-35; and ASTM A148, Grade-80-50.

C. Steel Forgings:
1. ASTM A668.

D. Bolts:
1. ASTM A307, ASTM A325, ASTM A354.

E. Filler Metal:
1. AWS Standards.

F. Cast Iron:
1. ASTM A48, Class 30, minimum 30,000 PSI tensile.

G. Malleable Iron:
1. ASTM A47 and ASTM A197.

H. Aluminum:
1. ASTM B308 for particular alloy in standard shapes and extrusions.
2. ASTM B26 for castings.

I. Stainless Steel:
1. ASTM A484 and ASTM A276.
2. Concealed: Type 302 or Type 304.
3. Exposed: Type 316.
   a. Finish: ASTM A480 AISI finish No. 4, unless otherwise indicated.

J. Masonry Anchorage Devices:
1. Standard manufactured items.
2. Lead expansion shields for machine screws and bolts 1/4 IN and smaller: Head out embedded nut type.
3. For machine screws and bolts larger than 1/4 IN: Manufacturers' standard.
4. Bolt anchor expansion shields for lag bolts: Zinc alloy, long shield anchors.
5. Bolt anchor expansion shields for bolts: Closed end bottom bearing type.
6. Anchor to embed or set device in setting compound or epoxy grout where shown.

K. Fasteners:
1. Galvanized or stainless where built into exterior walls.
2. Select fasteners for type, grade and class required.
3. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A.
4. Lag Bolts: Square or octagonal head type.
5. Machine Screws: Cadmium plated steel.

6. Wood Screws: Flat head carbon steel.
7. Plain Washers: Round carbon steel.
8. Lock Washers: Helical spring carbon steel.

L. Non-shrink Grout:
1. Compressive strength: 9000 PSI at 7 days.
2. Base Product: 1107 Advantage Grout by Dayton Superior.

M. Abrasive Warning Tape:
1. Self-adhering, tape with slip resistant mineral surface.
2. Color: Safety Yellow.
3. Width: 2 IN, except where noted otherwise.
4. Tape Type 2:
   a. Base Product: Safety-Walk 530 Conformable by 3M.
   b. Backing: Aluminum foil.
   c. Thickness: 0.035 IN.
   d. Use Type 2 at top and bottom rungs of ladders.

2.3 FABRICATION

A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.

B. Shop fabricate in as large assemblies as practicable.

C. Anchorage Accessories:
1. Items required securing wood to metal, wood to masonry, metals to masonry or concrete, metal to metal or metal to other items.

D. Drill or punch holes with smooth edges for temporary field connections and attachment of work by other trades.
1. Conceal fastenings where practicable.

E. Make permanent shop and field connections with continuous fillet type welds.
1. Grind exposed welds smooth.

F. Supply items required to complete construction and installation.

G. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.4 FINISHES

A. Items not to receive coatings:
1. Surfaces scheduled to be fireproofed with spray-on material.
2. Machined surfaces.
3. Surfaces adjacent to field welds.
4. Contact surfaces of bolt connections at slip connections.
5. Top flanges of beams to receive shear connectors.
6. Items for which no coating or field finish is specified.

B. Shop Primer for Interior Non-wet Items:
1. Primer: Coordinate with field applied finish systems specified in Section 09 91 23.
2. Apply primer for interior finish paint to following surfaces not receiving other coating:
   a. Surfaces exposed on interior.
3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
4. Apply in accordance with paint manufacturer's instructions.
   a. Apply minimum 0.002 IN, dry film thickness.

C. Hot-dip Galvanized (HDG) Coating for Exterior Items:
   1. Galvanize (HDG) the following items:
      a. Items to be installed on site, roof or other areas that are outside of building enclosure walls. This shall include items attached to exterior walls of building.
      b. Items to be installed in wet or humid (>70 PCT RH) areas of building.
      c. Partial listing of items to receive HDG:
         1) Masonry lintels, ledge angles and shelf angles.
         2) Pipe Bollards.
         3) Exterior Ladders, Stairs and railings.
         4) Exterior gratings and substructure.
         5) Exterior equipment supports.
         6) Similar items which are exposed to weather or built-in to Exterior walls.
         7) Other items indicated.
   2. Clean thoroughly before galvanizing.
   3. Galvanize in accordance with ASTM A123.

D. Galvanizing Repair Coating:
   1. Tnemec Series 94-H20 Hydro-Zinc.
   2. ZRC Worldwide, Galvilite 221.
   3. Sherwin Williams Zinc Clad III HS 100.

E. Finish Painting:
   1. Exterior: See Section 09 91 13.
   2. Interior: See Section 09 91 23.

2.5 METAL FABRICATIONS

A. Ladders:
   1. Design to comply with following regulations:
      a. ANSI-A14.3.
      b. OSHA 29 1910.27.
   2. Material:
      a. Exterior Ladders: Galvanized steel, painted by Section 09 91 13.
      b. Interior Ladders: Shop-primed steel, painted by Section 09 91 23.
   3. Side rail members: Minimum 1/2 x 2 IN.
   4. Rungs: Minimum 3/4 IN round or square bars.
   5. Punch rungs through side rails and weld.
   6. Size to support concentrated moving load of 200 LB.
   7. Minimum clearance from centerline of rung to wall or obstruction: 7 IN.
   8. Minimum ladder width: 16 IN between side rails.
   9. Rung spacing: 12 IN O.C.
   10. Apply abrasive warning tape Type 2 to top and bottom rung of ladders.
   11. Elevator pit ladders:
      a. Comply with general items above, except as amended by following:
      b. Extend from bottom of pit to 4 FT above floor level.
      c. Rungs: Minimum 3/4 IN round or square bars.
      d. Rung clearance: 4-1/2 IN clear from face of rung to face of pit wall.
      e. Maximum projection from wall: 8 IN or as directed by locally adopted codes and elevator running clearances.
      f. Comply with ANSI/ASME-A17.1.
      g. Coordinate final dimensions and locations with Elevator contractor.

B. Metal Gratings:
   1. Complying with NAAMM Metal Bar Grating Manual.
   2. Material and thickness (except were otherwise indicated):
      a. Galvanized steel, nominal 1-1/4 IN x 3/16 IN thick.
   3. Load capacity: Support minimum uniform load of 200 PSF.

4. Provide hold down clips.
5. Serrated tops at exterior.
6. Slip resistant tops at interior.
7. Furnish with frames and support items of comparable material and finish.

C. Steel Support Angles, Support Frames, and Loose Lintel Steel Members:
1. ASTM A36 steel, Sizes and configurations as indicated.
2. Items to be hot dip galvanized:
   a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
   b. Items set into exterior walls.
3. Shop Prime interior items (in non-wet areas).

D. Miscellaneous Equipment Supports:
1. ASTM A36 steel, Sizes and configurations as indicated.
2. Examples of items included:
   a. Supports for Folding Partitions, Operable Walls, Coiling Doors and Grilles.
   b. Supports for ICU Doors.
   c. Support of Medical Equipment including Surgical Lights, Power Columns. And other items indicated.
   d. Ceiling hung toilet partitions.
   e. Other miscellaneous support items as indicated.
3. Items to be hot dipped galvanized:
   a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
   b. Items set into exterior walls.
4. Shop Prime interior items (in non-wet areas).

E. Bollards:
1. Provide where indicated.
2. Supply items required to complete construction and installation.
3. Minimum Workmanship Standards (unless noted otherwise): Class 1, Architectural, per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.
4. Utility Bollards Type UB-1:
   a. 6 IN nominal diameter extra strength, HDG (galvanized), steel pipe or round structural tube.
   b. Length: Unless otherwise indicated; minimum 42 IN projection above ground and 36 IN embedment into concrete.
   c. Fabricate with welded on anchors.
   d. Fill bollard with 3000 PSI concrete with rounded top.
   e. Field paint by Division 09.
5. Steel Bollards with Decorative Cover Type DB-1:
   a. Assembly including a concrete-filled steel pipe with a decorative cover sleeve.
   b. Steel pipe bollard:
      1) 6 IN nominal diameter extra strength, hot dip galvanized steel pipe or round structural tube.
      2) Length: Unless otherwise indicated; minimum 42 IN projection above ground and 36 IN embedment into concrete.
      3) Fabricate with welded on anchors.
      4) Fill with 3000 PSI concrete, flush at top.
   c. Decorative Bollard Covers:
      1) Description: 1/8 IN thick, HDPE.
      2) Size as appropriate for steel bollard.
      3) Color: To be selected by Architect.
         a) Five year warranty for color-fastness, cracking and UV-resistance.
      4) Dual reflective stripes near top of cover.
      5) Base Product: BollardGard by Innoplast.

F. Ornamental Steel Fence:
   1. Steel member Shapes and Sizes: As indicated on Drawings.
   2. Steel members fabricated to dimensions and configurations indicated on Drawings.
   3. Shop-fabricate to maximum extent possible for ease of site installation.
   4. Galvanic Protection:
   5. For items located on exterior or wet areas.
      a. Weld connections prior to application of hot-dip galvanization.
      b. Hot-dip galvanize fabricated units in accordance with ASTM A123.
   6. Field Painted (for units to be located on interior, non-wet areas):
      a. Shop Prime prior to shipping units to site.
      b. Prepare and Paint in field by Division 09.
   7. Vinyl Coated:
      a. Factory finished components.
      b. Architect select from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Installation constitutes acceptance of responsibility for performance.

C. Verify wall backing has been installed for wall-mounted items specified in this Section.
   1. See Section 09 22 16.

3.2 INSTALLATION

A. General:
   1. Set work level, true to line, plumb.
   2. Weld field connections and grind smooth.
   3. Conceal fastenings where practical.
   4. Secure metal to wood with lag screws of adequate size with appropriate washers.
   5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
      a. Use expansion bolts, toggle bolts, or screws for light duty service.
   6. Meet structural requirements for erecting items of structural nature.
   7. Do not field splice fabricated items unless size requires splicing.
   8. Weld splices.
   9. Provide fabricated items complete with attachment devices as required to install.

B. Galvanic Repair:
   1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer’s recommendations.
   2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.

C. Bollards:
   1. Direct buried:
      a. Hole Depth: 6 IN deeper than embedment length specified for bollard.
      b. Hole Diameter: 24 IN diameter for 6 IN diameter bollard.
      c. Set bollards plumb and to the exposure height indicated.
   2. Surface bolted and other means of attachment: Install as detailed.
   3. Fill annular space with concrete fill having a compressive strength of at least 3000 PSI.
   4. Paint or cover with decorative sleeves as scheduled.

END OF SECTION

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SECTION 05 51 00
METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Steel Stairs and Railings, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Provide Steel Stairs and Railings engineered to support dead, live, lateral and seismic loads indicated:
   1. Include calculations for load-bearing components of stairs and landings.
   2. Comply with Section 01 71 21, Specialty Engineering Requirements.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.
   4. Physical adequacy of structural design and conformance with applicable building codes are responsibility of stair fabricator.

B. ASTM International:
   1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
   2. ASTM A36 Standard Specification for Carbon Structural Steel
   3. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings
   4. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   5. ASTM A148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
   6. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
   7. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
   8. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
   9. ASTM A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
   10. ASTM A480 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
   11. ASTM A484 Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
   12. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
   13. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
   14. ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
   15. ASTM E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester

C. American Institute of Steel Construction (AISC)
   1. Steel Construction Manual

D. American Iron and Steel Institute (AISI):
   1. Specification for the Design of Cold-Formed Steel Structural Members.

E. American Welding Society (AWS):
   1. ANSI/AWS D1.1 Structural Welding Code - Steel.
   2. ANSI/AWS D1.3 Structural Welding Code - Sheet Steel.

F. National Association of Architectural Metals Manufacturers (NAAMM):
   1. NAAMM AMP-555, Code of Standard Practice for the Architectural Industry
      a. Class 1, Architectural.
   2. NAAMM AMP 521, Pipe Railings Systems Manual, and NAAMM AMP-510, Metal Stairs Manual.

G. Workmanship Standards:
   1. Railing System Joints: Continuous fillet weld. Type 1 Railing System Joint Construction.
   2. Comply with National Ornamental & Miscellaneous Metals Association (NOMMA).

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. For each type of material and accessory.

C. Shop Drawings:
   1. Layout drawings indicating rise and run.
   2. Include full sections, details, handrails, guardrails and anchoring methods.

D. Project Information:
   1. Structural calculations for stairs, handrails, guardrails and embeds indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Stairs and Railing:
   1. Shop fabricated.

B. Galvanizing Repair Paint:
   1. Base:
      a. Tnemec.
   2. Optional:
      a. ZRC Worldwide.
      b. Sherwin-Williams.

C. Shop Primer:
   1. Base:
      a. As recommended by finish coat manufacturer for substrate.
   2. Optional:
      a. Sherwin-Williams.
      b. Tnemec.

D. Non-shrink Grout:
   1. Base:
      a. Dayton Superior Corporation.
   2. Optional:
      a. Sauereisen.
      b. CGM Building Products (Por-Rok).

E. Abrasive Warning Tape:
   1. Base:
      a. 3M.

F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

A. Design, fabricate, and install in compliance with applicable codes.
   1. Enclosed Stairs: Commercial Class per latest edition NAAMM AMP-510, Metal Stairs Manual.
   2. .

B. Fabricate and design stair and landing assembly to support larger of following loads, whichever results in strongest components:
   1. Design Concentrated Moving Load: 300 LBS.
   2. Design Uniform Load: 100 PSF.
   3. Form surface with slip resistant materials.
      a. See Section 03 35 00.

C. Handrails and Guardrails:
   1. Form to profiles indicated.
   2. Utilize following loads for design of indicated members and their direct or indirect connection to building superstructure.
      a. Handrails and top rail of Guardrails, Uniform Load: 50 LBS/LF minimum applied in any direction.
      b. Handrails, Concentrated Load: 200 LBS minimum applied in any direction at any point along rail.
      c. Guardrail, Concentrated Load: 200 LBS minimum applied in any direction at any point along rail.
      d. Uniform and concentrated loads need not be concurrently applied.
   3. Intermediate Rails, Balusters, Panels, and other Infill Materials:
      a. Design to withstand a horizontal applied normal load of 50 LBS minimum on an area not to exceed 1 SQFT including openings and space between rails.

D. Support stairs at locations indicated.

2.3 MATERIALS

A. Hangers:
   1. Minimum 1/2 IN diameter steel rod.
   2. Connect hangers to beams only.
   3. Hanger-slab connections are not permitted.
   4. Maximum 2 IN eccentricity from beam centerline to hanger centerline.
   5. Connect hangers to structure with through-bolt type connections when in tension.
      a. Recess top plate and nut in slab and grout smooth.
   6. Expansion anchor type connections in tension are not allowed.

B. Support Brackets and Posts:
   1. Attach to structure as required, use welded connections wherever possible.
   2. Use concrete expansion anchors for shear connections only.

C. Stringers:
   1. Channel shape: 3/16 IN x 12 IN deep steel plate, minimum.
   2. Outside stringers shall span flight length plus landing.
      a. Intermediate supports are not allowed without prior approval.

D. Treads:
   1. Minimum 14 GA steel pans with angle supports as required.

2. Bar Grating with integral steel nosing and angle brackets, complying with NAAMM Metal Bar Grating Manual.

E. Risers:
1. Minimum 14 GA steel.

F. Landings:
1. Minimum 10 GA pans with angle supports as required.
2. Bar Grating with integral steel nosing, angle and channel brackets, complying with NAAMM Metal Bar Grating Manual.

G. Metal Lath:
1. Self-furring diamond mesh with dimples or embossed ribs.
2. Maintain metal lath, 1/4 IN minimum, above tread and landing steel pans.

H. Abrasive Warning Tape:
1. Base Product: Safety-Walk 630 General Purpose Tread by 3M.
2. Use at first and last stair nosings of stair runs.
3. Self-adhering tape with slip resistant mineral surface.
4. Color: Safety Yellow.
5. Width: 2 IN, except where noted otherwise.
6. Thickness: 0.03 IN.
7. Do not use where rubber stair treads or carpet is scheduled.

I. Handrails:
1. Round Tube: HSS 1.66.x 0.140; ASTM A500.
2. Minimum Clearance from wall: 2-1/4 IN.
3. Maximum projection from wall: 4-1/2 IN.
4. Maximum span between mounting brackets and/or newel posts: 8 FT.
5. Return ends of wall mounted rails to wall.
6. Make rails smooth with no projections to prevent a hand from sliding along entire length.

J. Guardrails:
1. Increase sizes where appropriate to resist design loads.
2. Refer to drawings for depiction of guardrails.
3. Maximum span between mounting brackets and newel posts: 8 FT.
4. Newel posts:
   a. Round tube: HSS 1.66.x 0.140; ASTM A500.
   b. Round tube: Schedule 40 Pipe: 1-1/4 IN STD; ASTM A53.
5. Top rails and bottom rails:
   a. Round tube: HSS 1.66.x 0.140; ASTM A500.
6. Balusters/pickets:
   a. Definition: Vertical elements spanning between top rails and bottom rails in a guardrail panel.
   b. Round bar: 1/2 IN .
7. Intermediate Rails:
   a. Construct parallel to top and bottom rails and spanning the length of a guardrail panel.
   b. Use only in non-public areas.
   c. Round tube: HSS 1.50.x 0.083; ASTM A500.

K. Non-shrink Grout:
1. Compressive strength: 6,000 PSI at 7 days.
2. Base Product: 1107 Advantage Grout by Dayton Superior Corporation.

L. Anchorage Devices:
1. Items required securing wood to metal, wood to masonry, metals to masonry, or concrete, metal-to-metal or metal to other items.
2. Galvanized or stainless where built into exterior walls.
3. Select fasteners for type, grade, and class required.

4. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A.
5. Lag Bolts: Square or octagonal head type.
6. Machine Screws: Cadmium plated steel.
7. Wood Screws: Flat head carbon steel.
8. Plain Washers: Round, carbon steel.
9. Lock Washers: Helical spring carbon steel.
10. Lead expansion shields for machine screws and bolts 1/4 IN and smaller: Head out embedded nut type.
    a. For machine screws and bolts larger than 1/4 IN: Manufacturers' standard.

2.4 FABRICATION

A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.

B. Drill or punch holes with smooth edges for temporary field connections and attachment by work of other trades.

C. Qualify welding processes and welding operators in accordance with American Welding Society.

D. Make permanent shop and field connections with continuous fillet type welds.

E. Grind exposed welds smooth and blend seamlessly into pipe.

F. Conceal fastenings where practicable.

G. Shop fabricate in as large assemblies as practicable.

H. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.5 FINISHES

A. Shop Primer for Interior (non-wet) Items:
1. Coordinate with finish systems specified in Section 09 91 23.
2. Apply primer for interior finish paint to following surfaces not receiving other coating:
    a. Surfaces exposed on interior.
3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
4. Apply in accordance with paint manufacturer's instructions.
    a. Apply minimum 0.002 IN, dry film thickness.

B. Field Applied Finish Paint:
1. See Section 09 91 23.

C. Hot-dip Galvanized (HDG) Coating for Exterior items:
1. Galvanize following items:
    a. Handrails, guardrails and items installed outside building enclosure on site, roof, and walls.
    b. Items installed in wet or humid areas of greater than70 PCT RH, inside building.
    c. Apply HDG coating after cutting, drilling, grinding, welding and other fabrication has been completed.
2. Clean thoroughly prior to galvanizing.
3. Galvanize in accordance with ASTM A123.

D. Galvanizing Repair Coating:
1. Tnemec Series 94-H20 Hydro-Zinc.
2. ZRC Worldwide, Galvilite 221.
3. Sherwin Williams Zinc Clad III HS 100.

E. Finish Painting:
   1. Exterior: See Section 09 91 13.
   2. Interior: See Section 09 91 23.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Installation constitutes acceptance of responsibility for performance.

C. Verify wall backing has been installed where required for handrails and similar wall-mounted items.

3.2 INSTALLATION

A. General:
   1. Shim and grout as required to set work plumb, level, and true to line.
   2. Weld field connections and grind smooth.
   3. Conceal fastenings where practical.
   4. Secure metal to wood with lag screws and washers.
   5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
   6. Meet design requirements for erecting structural components.
   7. Do not field splice fabricated items unless size requires splicing.
   8. Weld splices and grind smooth.
   9. Provide fabricated items complete with attachment devices as required to install.

B. Galvanic Repair:
   1. Repair abraded areas with galvanizing paint in accordance with manufacturer's recommendations.
   2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.

C. Handrails:
   1. Furnish handrails complete with brackets.
   2. Coordinate locations and installation of wall backing.
   3. Where posts are indicated to be set in sleeves, provide galvanized steel sleeves having a minimum wall thickness of 1/8 IN.
   4. Set newels or balusters in sleeves with non-shrink grout.
   5. Where setting is required for exterior, hold non-shrink grout back 1/4 IN from surface and fill flush with self-leveling sealant.

D. Abrasive Warning Tapes:
   1. Schedule installation immediately prior to Substantial Completion.
   2. Clean and prepare surfaces to receive tape prior to application.
   3. Apply tape in accordance with manufacturer's instructions.
   4. Where tape is damaged by construction activities, remove, clean, and reapply new material.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Rough Carpentry, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Lumber Grading Rules and Species:
   1. US Department of Commerce (DOC):
      a. PS 20 American Softwood Lumber Standard.
   2. Western Wood Products Association (WWPA).
   3. Southern Forest Products Association (SFPA).

B. Plywood Grading Rules and Recommendations:
   1. US Department of Commerce (DOC):
      a. Softwood plywood: PS1 Structural Plywood.
   2. American Plywood Association (APA).

C. Preservative and Fire Retardant Treatment Standards:
   1. American Wood Protection Association (AWPA):
      a. AWPA U1Treated Wood.
      b. AWPA P5 Standard for Waterborne Preservatives.
   2. Underwriters Laboratories (UL)
   3. ASTM International requirements:
      a. ASTM E84 Standard Test Method for Surface Burning Characteristics
      b. ASTM D2898 Standard Method of Accelerated Weathering of Fire Retardant Treated Wood for Fire Testing
      c. ASTM D3201 Standard Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Based Products

D. Factory Marking:
   1. Identify type, grade, moisture content, inspection service, producing mill, and other qualities.
   2. Mark each piece of fire retardant treated material with Underwriters Laboratory Classification mark and fire-retardant treatment for identification.
   3. International Building Code (IBC):
      a. Requirements for identification and labeling.

1.3 SUBMITTALS

A. Project Information:
   1. Certification of fire retardant treated material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire-retardant Treated Dimension Lumber and Plywood:
   1. Base:
      a. Hoover Treated Wood Products, Inc.

2. Optional:
   a. Lonza Group Limited
   b. Western Wood Preserving Company

B. Preservative Treated Lumber:
1. Base:
   a. Lonza Group Limited
2. Optional:
   a. Stella-Jones Incorporated
   b. Western Wood Preserving Company

2.2 MATERIALS

A. Dimensional Lumber and Plywood:
1. Thoroughly seasoned, non-treated, well-fabricated materials.
2. Longest practical lengths and sizes.
3. Application, except where treated types are indicated:
   a. Non-structural framing, blocking, backing, nailers, grounds, and similar members.
   b. Other locations where indicated.

B. Fire-retardant Treated Lumber and Plywood (FRT):
1. Flame spread index: Less than 25.
2. Smoke developed index: Less than 450.
3. Free of halogens, sulfates, chlorides, arsenic, ammonium phosphate, formaldehyde, and urea formaldehyde.
4. Kiln dried after treatment, (KDAT).
5. FRT material for interior and above grade locations:
   a. Base: Pyro-Guard by Hoover Treated Wood Products, Incorporated
   b. Optional:
      1) Dricon FRT by Lonza Group Limited
      2) FirePro by Western Wood Preserving Company.
   c. Natural wood products treated to add fire-retardant qualities.
   d. Type A: not more than 28 PCT moisture when tested according to ASTM D3201.
   e. Interior and above grade applications include but not limited to:
      1)
      2) Wood in concealed spaces.
      3) Framing, blocking, cants and nailers within roof covering and waterproofing systems.
      4) Interior wood items in direct contact with exterior concrete and exterior masonry walls.
      5) Plywood backing panels for electrical, telecommunication equipment.
      6) Similar locations where wood products are indicated and building code does not permit non-fire-resistive treated products.
      7) Above grade dimensional lumber and plywood, unless indicated otherwise.
         a) Exception: Upgrade to exterior grade where scheduled in the following article.
6. FRT material for exterior and wet locations:
   a. Base:
      1) Exterior Fire-X by Hoover Treated Wood Products, Incorporated
   b. Optional:
      1) Dricon FRX by Lonza Group
   c. Natural wood products treated to add fire-retardant qualities plus decay and termite resistance.
   d. Non-leaching treatment under direct exposure to precipitation, sunlight, and effects of weather.
   e. Exterior applications include but not limited to:
      1) Fire-treated wood that is directly exposed to weather.

2) Fire-treated wood in areas of high-humidity, Greater than 80 PCT RH.
3) Other areas where indicated.

C. Preservative Treated Lumber and Plywood:
1. Natural wood products treated to add decay and termite resistance.
2. Base:
a. FrameGuard by Lonza Group Limited
3. Optional:
a. Lumber Products by Stella-Jones Incorporated
b. Advance Guard by Western Wood Preserving Company
4. Preservatives:
a. Compatible with direct exposure to precipitation, sunlight and effects of weather.
b. Authenticate by factory marking each piece with manufacturer's mark and applicable standards.
c. Acceptable treatments:
1) Alkaline Copper Quaternary (ACQ).
2) Copper Boron Azole (CBA).
3) Borate based (BORON).
5. Lumber Species:
a. Southern Pine.
b. Mixed Southern Pine.
c. Hem-Fir.
d. Spruce.
e. Pine.
f. Other species meeting requirements.
6. Plywood:
a. Grading:
1) PS1, B-C Grade.
2) PS1, A-C Grade where exposed.
b. Veneers:
1) Softwood species.
2) Glue with waterproof adhesives.
7. Application:
a. Below grade, or in contact with earth.
b. Where indicated in Drawings.

D. Sill Sealing Gaskets:
1. Closed cell neoprene foam.
2. Thickness: 1/4 IN .
3. Match width of sill members indicated.

E. Adhesives for bonding furring, sleepers, sills and similar items to concrete or masonry:
1. Approved for indicated use by adhesive manufacturer.
2. Comply with ASTM D3498.

F. Water-Repellent Preservative:
1. Treat of exposed ends of posts and beams.
2. National Wood Window and Door Association (NWWDA) tested and accepted formulation.

2.3 FASTENERS

A. General:
1. Provide fasteners of size and type indicated that comply with requirements specified for material and manufacture.
2. Where rough carpentry is exposed to weather, in contact with earth, pressure-preservative treated, or in area of high relative humidity:
a. Use fasteners with hot dip zinc coating complying with ASTM A153.
b. Use fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1.

F. Bolts: ASTM A307, Grade A steel bolts with ASTM A563 hex nuts and washers.

G. Expansion Anchors:
1. Tested in accordance with ASTM E488.
2. Anchor bolt and sleeve assembly:
   a. Masonry assemblies: Sustain load equal to 6 times load imposed when installed in unit.
   b. Concrete assemblies: Sustain load equal to 4 times load imposed when installed in unit.
3. Interior applications:
   a. Carbon-steel components.
   b. Zinc plated to comply with ASTM B633, Class Fe/Zn 5.
4. Exterior and wet applications:
   a. Stainless Steel components, ASTM F593 and ASTM F594 Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine conditions under which work is to be installed.

B. Verify measurements, dimensions, and details before proceeding.

C. Coordinate location of furring, nailers, blocking, grounds and similar supports.

D. Correct unsatisfactory conditions.

3.2 INSTALLATION OF ROUGH CARPENTRY

A. Form to shapes indicated.

B. Cut and fit accurately.

C. Set work to required levels and lines, plumb and true.

D. Shim as required.

E. Provide wood grounds or nailers as required for attachment of other work and surface applied items.

F. Grounds:
1. Dressed, key beveled lumber.
2. Minimum 1-1/2 IN wide x thickness required to bring face of ground even with finish material.
3. Remove temporary grounds when no longer required.

G. Wall Blocking:
1. Provide in-wall fire-treated wood blocking reinforcement where following items are required to be wall-mounted to interior walls:
   a. Architectural casework, millwork, cabinets, shelving, wardrobes, and bookcases.
   b. Handrails at stairwells.
   c. Between studs at height of door stop, behind stop.
2. Metal wall backing:
   a. See Section 09 22 16.

H. Anchor work to support applied loading.
1. Provide washers under bolt heads and nuts.

2. Fasten plywood in accordance with APA recommendations.
3. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
4. Predrill holes to avoid splitting wood with fasteners.
5. Do not drive threaded friction type fasteners.

3.3 INSTALLATION OF BLOCKING AND NAILERS FOR ROOFING AND PARAPETS

A. Install in accordance with ANSI/SPRI ES-1 Wind Design Standard for Edge Systems Used With Low Slope Roofing Systems.

B. Minimum Wood Member Size: 2 IN x 6 IN nominal.

C. Fasteners:
1. Corrosion resistant.
   a. Hot dip galvanized: Comply with ASTM A153 or ASTM A653, Class G185.
   b. Stainless steel: Types 304 or 316.
2. Countersink heads of fasteners.
3. Types required for substrate conditions.
4. Fasteners of diameter and spacing required to resist forces indicated.
5. Spacing:
   a. Threaded anchor bolts; 3/8 IN or larger:
      1) Provide 5/8 IN OD washers or larger.
      2) Maximum spacing: 48 IN OC.
      3) Stagger 1/3 nailer width.
   b. Other fastener types:
      1) Maximum Spacing:
         a) Typical: 12 INOC.
         b) Up to 16 IN OC where necessary to match spacing of structural members.
      2) Stagger 1/3 nailer width.
      3) Install 2 fasteners and within 6 IN of nailer ends.

D. Anchor nailers to resist minimum vertical force of 300 LBS/LF in any direction.
1. Locate fasteners approximately 4 IN from ends but not less than 3 IN .
2. Use minimum of 3 anchors for each nailer.
3. Where members are wider than 6 IN , stagger fasteners from side to side to avoid splitting of the wood member.
4. Corner region enhancements:
   a. Double the above listed vertical force which must be resisted.
   b. Length and width of corners as prescribed by ANSI/SPRI RP-4:
      1) 40 PCT of the building height, but not less than 8-1/2 FT .

E. Nailers used for perimeter securement of roofing membranes:
1. Install nailers where indicated and where required to secure perimeter of membrane roofing.
2. Match height of nailers to adjacent insulation.
3. Where multiple layers are required to match depth of insulation:
   a. Attach base layer as indicated in General Requirements above.
   b. Apply a bead of construction adhesive between laminations.
   c. Attach subsequent layers using fastener type which is appropriate for wood-to-wood securement.
   d. Size and locate fasteners as required to resist uplift loading indicated.

F. Install blocking as indicated for securement of sheet metal edge flashings, parapet copings, and similar items.

3.4 INSTALLATION OF FIRE RETARDANT TREATED WOOD

A. Fire retardant treated lumber and plywood used in structural applications shall be applied according to lumber and plywood strength tables provided by manufacturer.

B. Use only fasteners approved by the manufacturer of fire retardant treated or preservative treated wood.

C. Field Cuts:
   1. Dimensional Lumber: Do not rip or mill fire retardant treated lumber.
      a. Cross cuts, joining cuts, and drilling holes are permitted.
   2. Plywood: Fire retardant treated plywood may be cut in any direction.
   3. Field treat cuts and holes in preservative and fire retardant treated material in accordance with AWPA M4.

END OF SECTION

SECTION 06 16 43
GYPSUM SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Gypsum Sheathing, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
   2. ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers.

B. Gypsum Association (GA):
   1. GA-253 Application of Gypsum Sheathing

1.3 SUBMITTALS

A. Product Data:
   1. Material properties and test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gypsum Sheathing:
   1. Base:
      a. Georgia Pacific.
   2. Optional:
      a. CertainTeed.
      b. Continental Building Products.
      c. National Gypsum Company.
      d. USG.

B. Seam Sealant:
   1. Base:
      a. See Section 07 92 13.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Exterior Gypsum Sheathing:
   1. Water-resistant, mold-resistant suitable for long term weather exposure during construction.
   2. Minimum Mold Resistance: 10 rating per ASTM D3273.
   3. Minimum Thickness: 1/2 IN () thick.
      a. Upgrade to 5/8 IN () thick, Type X product where fire rated exterior walls are indicated.
      b. Upgrade to appropriate non-sag product where sheathing is used horizontally as in soffits.
   4. Base Product:
      a. Dens-Glass Gold Exterior Sheathing by Georgia Pacific.

B. Seam Sealant:
   1. Coordinate sealant for compatibility with selected air or vapor barrier systems and sheathing.

C. Fasteners:
   1. Screws: Cadmium plated or stainless.
   2. Clips: Galvanized or zinc.
   3. Sized as required.
   4. Thread count as appropriate for stud materials specified.

D. Sheathing accessories: Galvanized, or zinc.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrate for suitability to accept work.

B. Start of work constitutes acceptance of substrate and responsibility for performance.

3.2 INSTALLATION

A. Exterior Sheathing:
   1. Align edges of sheathing panels on stud centerlines.
   2. Screw to exterior of each stud as recommended by manufacturer.
   3. Butt sheathing boards together tightly:
      a. Maximum gap between boards: 1/8 IN.
   4. Seal seams with sealant by filling all joints and troweling smooth on sheathing surface to a depth of 1/16 IN and a width of 2 IN.

B. Sheathing at Roof Side of Parapet Walls:
   1. Non-Fire Rated Parapets:
      a. Use Fire Retardant Treated (FRT) Plywood as sheathing on the roof-side of parapet.
      b. FRT Plywood is specified in Section 06 10 00.
   2. Sheathing not required where parapet back-up walls are CMU.

END OF SECTION

SECTION 07 27 29
FLUID APPLIED AIR BARRIER - VAPOR PERMEABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Fluid Applied Air Barrier - Vapor Permeable, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Air and vapor barrier systems shall be manufactured by firm with minimum of twenty (20) years of experience in production of waterproofing.

B. Installer Qualifications:
   1. Certified by Manufacturer and Air Barrier Association of America.
   2. Minimum five (5) years of continued experience in successful installation of vapor permeable water resistive air barrier products on similar project applications.

C. Provide primary materials of one manufacturer for each component required for work.

D. ASTM International (ASTM):
   1. ASTM D903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
   2. ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
   3. ASTM E96/E96M Test Methods for Water Vapor Transmission of Materials.
   4. ASTM E2178 Standard Test Method for Air Permeance of Building Materials.
   5. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   2. Details and isometrics at openings showing layouts of Air Barrier Flashings and sequence of installation.

B. Product Data:
   1. Manufacturer’s literature indicating specified material and required components.

C. Project Information:
   1. Written documentation demonstrating applicator’s qualifications.
   2. Minutes of Preinstallation Conference.

D. Contract Closeout Information:
   1. Manufacturer Warranty.
   2. Installer Warranty.

1.4 WARRANTY

A. Manufacturer five (5) year warranty that air and vapor barrier and accessories are free of defects.

B. Installer five (5) year warranty for air and vapor barrier and accessories have been installed in accordance with manufacturer's recommendations, and that components used in this Section have been sourced from one manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fluid Applied Air Barrier - Vapor Permeable:
   1. Base:
      a. Carlisle Coatings and Waterproofing Incorporated
   2. Optional:
      a. GCP Applied Technologies
      b. Henry Company
      c. W.R. Meadows
      d. Tremco
      e. Prosoco
      f. Pecora
      g. Dow Corning
      h. DuPont
      i. GE Silicone by Momentive Performance Materials
   3. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Air Permeance:
   1. Maximum 0.004 CUFTM/SF at 1.57 PSF water pressure differential, as tested in accordance with ASTM E2178.

B. Vapor Permeance:
   1. Minimum 10 Perms when tested in accordance with ASTM E96/E96M.

C. Application Window:
   1. Provide standard or low temperature wall membrane based upon ambient weather conditions at time of installation.

2.3 MATERIALS

A. Fluid Applied Air Barrier - Vapor Permeable:
   1. Single component membrane
   2. Base:
      a. Carlisle Fire Resist Barritech VP
   3. Optional:
      a. GCP Applied Technologies Perm-A-Barrier VP20
      b. Henry Air-Bloc 31 MR
      c. Meadows Air-Shield LMP
      d. Tremco ExoAir 230
      e. Prosoco R-Guard Cat 5
      f. Pecora XL-Perm
      g. DuPont Tyvek Fluid Applied Weather Barrier
      h. Dow Corning DefendAir 200
      i. GE Elemax 2600

B. Wall Primer:
   1. Use with through wall flashing and tapes applied to substrate.
   2. Liquid waterborne primer recommended for substrate by manufacturer.

C. Transition Membrane:
   1. Compatible with air barrier and adjacent substrate.
   2. As recommended by air barrier manufacturer.

D. Flexible Membrane Wall Flashing:
   1. Silicone rubber extrusion.
   2. Self-adhesive rubberized asphalt integrally bonded to cross-laminated polyethylene.

E. Joint Reinforcing Strip:
   1. Air barrier manufacturer's approved tape.

F. Substrate Patching Membrane:
   1. Manufacturer's standard trowel-grade substrate filler.

G. Joint Sealant:
   1. Compatible with air barrier and adjacent substrate.
   2. Single component silicone.
   3. 1 or 2-component polyurethane foam sealant.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine conditions for compliance with requirements for installation, tolerances and other specific conditions affecting performance of air barrier.

B. Verify substrate is smooth and free of voids, spalled areas and sharp protrusions.

C. Remove deleterious materials from surfaces to be covered.

D. Do not proceed with installation until unsatisfactory conditions have been corrected.

E. Installation indicates acceptance of substrates and responsibility for performance.

3.2 INSTALLATION

A. Install according to manufacturer's directions.

B. Perform work only when existing and forecast weather conditions are within limits established by manufacturer.

C. Join air barrier in an airtight and flexible manner to air barrier material of adjacent systems, allowing for relative movement of systems due to thermal and moisture variations and creep, between:
   1. Foundation and walls
   2. Walls and windows or doors
   3. Different wall systems
   4. Wall and roof
   5. Wall and roof over unconditioned space
   6. Walls, floors and roof across construction, control and expansion joints
   7. Walls, floors and roof to utility, pipe and duct penetrations

D. Exterior Sheathing Panels:
   1. Pre-treat joints with reinforced self-adhesive tape or mesh style wallboard tape.
   2. Caulk gaps greater than 1/4 IN.

E. Masonry Substrates:
   1. Fill voids, holes and mortar joints, with lean mortar mix, non-shrinking grout or pare coat.
   2. Apply air and vapor barrier over concrete block and brick with smooth trowel-cut mortar joints.

F. Fluid Applied Membrane:
   1. Spray or trowel apply continuous uniform film using multiple, overlapping passes to ensure even thickness and coverage.
   2. Carry membrane into openings minimum 2 IN.
   3. Seal brick-ties and penetrations as work progresses.

G. Transition Membrane:
   1. Overlap transition membrane onto each surface at beams, columns and joints.
   2. Tie in to window and door frames, spandrel panels, roof and floor intersections, and changes in substrate.
   3. Overlap adjacent pieces and roll seams.
   4. Seal top edge of flashing with termination mastic.

H. Flexible Membrane Through Wall Flashing:
   1. Fully adhere the flashing to substrate.
   2. Overlap adjacent pieces and roll seams.
   3. Trim bottom edge 1/2 IN back from exposed face of wall.
   4. Form end dams and seal seams at heads, sills and flashing terminations. Turn up ends a minimum of 2 IN or as recommended by manufacturer.
   5. Seal top edge of flashing with termination mastic.

3.3 PROTECTION AND CLEANING

A. Schedule work to ensure that system is covered as soon as practicable.
   1. Protect system from damage during subsequent operations.

B. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer.
   1. Apply temporary UV protection if system cannot be covered within published exposure time.

C. Clean spills, stains, and soiling from construction that would be exposed in completed work as recommended by manufacturer of affected construction.

D. Remove masking materials after installation.

END OF SECTION

SECTION 07 42 16
PREFORMED METAL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Preformed Metal Panels, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer franchised or approved in writing by manufacturer.

B. ASTM International (ASTM):
   1. ASTM A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   2. ASTM A755 Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
   3. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
   4. ASTM B209 Specification for Aluminum and Aluminum Alloy Sheet and Plate
   5. ASTM C645 Specification for Nonstructural Steel Framing Members
   6. ASTM C754 Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products
   7. ASTM C920 Specification for Elastomeric Joint Sealants
   8. ASTM C1363 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
   9. ASTM D968 Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
   10. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
   11. ASTM E84 Test Methods for Surface Burning Characteristics of Building Materials
   12. ASTM E119 Test Methods for Fire Tests of Building Construction and Materials
   13. ASTM E1996 Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

C. American Architectural Manufacturer's Association (AAMA):
   1. AAMA 501.1 Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure
   2. AAMA 501.2 Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
   3. AAMA 508-07 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
   4. AAMA 605.2 Voluntary Specification for High Performance Organic Coatings
   5. AAMA 2605 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

D. American Society of Civil Engineers (ASCE):
   1. ASCE 7 Minimum Design Loads for Buildings and Other Structures.

E. National Fire Protection Association (NFPA):
   1. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

2. NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):
1. Architectural Sheet Metal Manual.

G. UL:
1. UL 263 Fire Resistance Tests of Building Construction and Materials.
2. UL 723 Test for Surface Burning Characteristics of Building Materials.
3. UL 1040 Fire Test of Insulated Wall Construction.
4. UL 1715 Room Corner Test.

H. Provide Preformed Metal Panels engineered to support dead, live, and lateral, wind or seismic, loads indicated.
1. Comply with Section 01 71 21, Specialty Engineering Requirements.
2. Include headers and reinforcing members around openings.
3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Shop drawings:
1. Elevations showing each metal panel and attachment point.
2. Details of each condition of installation and attachment.
3. Details of each transition and termination.

B. Samples:
1. Manufacturers complete range of colors for selection.
2. Three 4 x 6 IN samples of panel in finish selected by Architect.

C. Project Information:
1. Structural calculations for Preformed Metal Wall Panels indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
a. Submit concurrent with Shop Drawings.
2. Certification of installer qualifications.
3. Field Water Infiltration Test reports.

D. Contract Closeout Information:
1. Warranty.

1.4 WARRANTY

A. Provide five (5) year warranty, on wall panels, flashing and associated work.

B. Warranty to cover waterproof integrity of panel system against leaks through wall.

C. Warranty signed by Contractor and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Preformed Metal Panels:
1. Base:
a. Centria – profiles as specified in 2.3 below.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Design Loads:
1. Design Preformed Metal Panels and anchorage to meet design loads.
   a. Wind Loads:
      1) Wind Pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
      2) 20 PSF minimum.
   b. Deflection Values: Use the most restrictive of the following:
      1) Limit deflection to values specified for Uniform Design Load Test.
      2) Limit deflection to comply with Building Code as locally adopted and amended.
      3) Limit deflection to L/175 or 3/4 IN maximum.

B. Thermal Expansion and Structural Movement:
1. Expansion and contraction, caused by changes in surface temperature equal to DT (delta T).
   a. Delta T for this project: 200 DEGF .
   b. Thermal contraction/expansion in this range shall not cause buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.
   c. Operating windows and doors shall function normally over this temperature range.

C. Structural Movements of Building Structure:
1. Inter-story drift caused by wind or earthquake forces.
   a. h/___ or ___ IN maximum.
2. Live load deflection of the supporting members.
   a. L/___ or ___ IN maximum.

D. Drainage:
1. Design Preformed Metal Panels to intercept, collect, contain, and drain water which may infiltrate system to exterior.

2.3 MATERIALS

A. Preformed Metal Panels:
1. Steel sheets: G90 coated per ASTM A653.
2. Nominal 16 IN wide.
3. Smooth.
4. Shiplap, tongue and groove edges which interlock.
5. Concealed fasteners.
6. Joints factory caulked or gasketed.

B. Profile:
1. CS-660 by Centria.
2. Minimum 22 GA .
3. Exterior finish:
   a. Minimum 70 PCT Kynar 500.
   b. Color as selected.
4. Interior finish:
   a. Prime coat of manufacturer's standard light color.

C. Perimeter Trim, Flashing and Accessories:
1. As required to complete entire wall panel installation.
2. Shop fabricated corners.
3. Match gage, color and finish of wall panels.

D. Fastening System as approved by Manufacturer to meet Design Criteria.

E. Subgirts and Supports:
1. G60 galvanized subgirts and intermediate support items as required for installation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to receive installation.

B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Erect system, per reviewed shop drawings.

B. Erect with concealed fasteners.

C. Use fasteners which lock entire unit to structural supports and prohibit negative load pulloff under design loads.

3.3 FIELD TESTING

A. Upon completion of walls, perform field water test in accordance with AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

B. Spray entire surface of exterior walls.

C. Repair leaks.

3.4 PROTECTION

A. Provide required temporary closures and flashings to maintain weather integrity, during and after erection.

END OF SECTION

SECTION 07 54 19
ADHERED PVC ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Adhered PVC Roofing System, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manufacturer authorized roofing installer.

B. Component products made by single manufacturer or approved for use with warranted system.

C. ASTM International (ASTM):
1. ASTM C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
2. ASTM C1303 Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
3. ASTM D6754 Standard Specification for Ketone Ethylene Ester Based Sheet Roofing, or D4434 Poly Vinyl Chloride Sheet Roofing depending on product.
4. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E96, Standard Test Methods for Water Vapor Transmission of Materials.

D. National Roofing Contractors Association (NRCA):
1. Roofing and Waterproofing Manual.

E. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
1. Architectural Sheet Metal Manual.

F. Underwriters Laboratories (UL):
1. UL 790, Standard for Tests for Fire Resistance of Roof Covering Materials.

G. Concrete Moisture Testing:
1. Test concrete decks for moisture in accordance with Section 07 16 04.

H. Fire Resistance Rating:
1. UL 790, Class A.
2. Assembly in conformance with fireproofing as specified.

I. Preinstallation Conference:
1. See Section 01 31 19.

1.3 SUBMITTALS

A. Shop Drawings:
1. Roof layout showing insulation thicknesses and details.
2. Indicate location of expansion joints, crickets, saddles, curbs, walkways, safety tiebacks, vents, drains and other penetrations.
3. Indicate slope direction, slope amount, and key vertical elevation points.
4. Profiles of flashing assemblies.
5. Installation Drawings.

B. Product Data:
   1. Manufacturer standard literature for vapor barrier, insulation and roofing system components, including adhesives and accessories indicating compliance with specification requirements.
   2. Manufacturer standard literature for roof coping system indicating components and accessories including anchor plate configuration.

C. Samples:
   1. Roofing manufacturer's facsimile of each sheet metal color for pre-selection.
   2. 3 IN x 5 IN samples of roofing manufacturer's sheet metal color for final approval.

D. Project Information:
   1. Minutes from Preinstallation Conference.

E. Contract Closeout Information:
   1. Warranty
   2. Maintenance Data:
      a. Include cleaning instruction.

1.4 WARRANTY

A. Five (5) year warranty signed by roofing installer.
   1. Warranty to include coverage of workmanship and installation.

B. Twenty (20) year weathertight warranty signed by roofing materials manufacturer.
   1. Warranty to include coverage for peak gusts of wind to:
      a. 90 MPH at 33 FT above ground.
   2. Warranty to include entire system: membrane, flashings, adhesives, sealants, counterflashings, insulation, fasteners, fastener plates, fastener strips, hard rubber or metal edging, metal termination bars, sheet metal copings and edge metal, and other material authorized by manufacturer.

C. Twenty (20) year warranty on 70 PCT PVDF coatings on edge metal and copings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Adhered PVC Roofing System:
   1. Base:
      a. Sika Sarnafil Inc.
   2. Optional:
      a. Johns Manville
      b. Carlisle
      c. Seaman Corporation.

B. Sheathing:
   1. Base:
      a. Georgia-Pacific.
   2. Optional:
      a. Same as Membrane Manufacturer.
      b. USG Corporation.
      c. National Gypsum.

C. Vapor Retarder (VR):
   1. Base:
      a. Same as Membrane Manufacturer.

D. Sheet Metal Coping and Edge Metal:
   1. Base:
      a. Provided by manufacturer of roofing system.

E. Other Materials:
   1. Base:
      a. Manufacturers as noted.

F. Walkway Protection:
   1. Base:
      a. Same as Membrane Manufacturer.

G. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Determine per Wind Load Design Guide for Low Sloped Flexible Membrane Roofing Systems published by SPRI.

B. Design roof system and anchorage fastener type and spacing needed to resist uplift pressures including roof covering and metal edge securement to meet design loads and satisfy requirements of applicable building codes, local amendments, and ANSI/SPRI RP-4.

C. Wind Loads: Use the greater of the following:
   1. Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in Structural Drawings.

D. Requirements applicable to designated warranty.

E. Roof Height and Parapet Height:
   1. As indicated.

F. Static pressure of building interior: < 0.5 IN water.

2.3 MATERIAL

A. Sheathing:
   1. Install over steel deck or existing roofing materials.
   2. Moisture resistant gypsum core with fiberglass mat and non-asphaltic surfacing.
   3. Minimum thickness: 5/8 IN.
   4. DensDeck Prime Roof Board by Georgia-Pacific.

B. Vapor Retarder:
   1. Rubberized asphalt membrane adhered to polyethylene or polyolefin top sheet.
   2. 30 MIL thick, minimum.
   3. Vapor Permeance: Not exceeding 0.05 Perm .
   4. UV protected for 90 day exposure.
   5. Primer or adhesive as recommended for substrate by manufacturer.
   6. Sarnavap Self-Adhered.

C. Roof Insulation:
   1. Furnished by roofing manufacturer.
   2. UL listed for assembly indicated.
   3. Provide crickets and saddles as required.
   4. Polyisocyanurate (PISO) roof insulation:
      a. Rigid, closed cell foam core bonded to heavy-duty glass fiber mat facers.
      b. ASTM C1289 Type II, Class 1.
      c. R-value: 5.6 per inch in accordance with ASTM C1303, CAN/ULC S770.
      d. Compressive strength: 25 PSI minimum per ASTM D1621, Grade 3.
      e. Dimensional stability: 2 PCT maximum linear change in seven days per ASTM D2126.

f. Minimum insulation thickness:
   1) Areas where tapered insulation is indicated:
      a) Minimum R-30 at roof drains.
      b) Taper to provide slope of 1/4 IN per FT .
   2) Areas with uniform insulation thickness (sloped structures):
      a) Minimum R-30 at roof drains.
g. Sarnatherm by Sika Sarnafil.

D. Cover Board:
1. Moisture resistant gypsum core with fiberglass facings.
   a. Minimum thickness: 5/8 IN .
2. DensDeck Prime Roof Board by Georgia-Pacific.

E. Roofing Membrane:
1. Reinforced PVC membrane with a lacquer coating.
2. Thickness: 60 MIL.
3. Membrane color and other items unless noted: Off-white.
4. G410 EnergySmart Bareback by Sika Sarnafil.

F. Flashing:
1. Roofing components shall be provided by membrane manufacture and included in roof system warranties.
2. Utilize type as indicated in full length pieces wherever possible to minimize number of splices.
3. Wall and curb flashing
   a. Non-reinforced membrane:
      1) Color: Same as indicated for main roof membrane.
      2) Thickness: 60 MIL minimum.
      3) Sheet flashing, cylindrical penetration boots and pre-molded corners.
      4) Base Product: G410 Membrane by Sika Sarnafil.
4. Polymer-clad metal:
   a. 24 GA galvanized steel coated with polymer to allow heat welding to room membrane and flashing accessories.
   b. Fabricate as required for conditions including Cap Flashing at parapets, Extended Wall Flashings, Scuppers, and other unique fabrications.
   c. Sarnaclad by Sika Sarnafil.

G. Coping:
1. Prefabricated metal, standard duty, multi-part assembly
   a. Cleats:
      1) 20 GA, thick, galvanized steel.
   b. Snap-on coping covers:
      1) Material:
         a) 70 PCT PVDF coating.
         b) 0.050 IN aluminum.
         c) Color: To be selected from manufacturer's standard colors.
      2) Parapet width: As indicated.
2. Internal metal chair drainage system to eliminate caulked joints
3. Wall Grip Coping by Sika Sarnafil.

H. Walkway Protection:
1. Type 1 - Roll:
   a. Polyester reinforced, weldable membrane with surface embossment.
   b. Secure with adhesive and hot air weld edges to roof membrane
   c. Thickness: 96 MIL .
   d. Roll width: 39IN .
   e. Color: Same as roofing membrane.

f. Base: SarnaTred-V by Sika Sarnafil.

I. Prefabricated Accessories:
1. Manufacturer's standard or approved.

J. Nailing Strips:
1. As detailed and required.

K. Pipe Flashings:
1. Provide for each pipe penetration; include clamps, adhesive and sealants.

L. Adhesives, cleaners, and primers:
1. As recommended by roofing manufacturer.

M. Fire-retardant Treated (FRT) wood blocking:
1. See Section 06 10 00.

N. Other Materials as required by manufacturer for complete system warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect entire area to be roofed for acceptability.

B. Surface on which insulation or roofing membrane is applied shall be clean, smooth, dry, and free of projections such as fins, sharp edges or foreign materials.

C. Do not allow grease, fats, oils and other contaminants to contact roofing membrane.

D. Correct unsatisfactory conditions.

E. Commencement of roofing activities constitutes acceptance of conditions affecting installation and roofing system performance.

3.2 INSTALLATION

A. Sheathing:
1. Install per UL requirements.
2. Install base sheathing with long dimension perpendicular to deck flute direction.
3. Lay sheathing tightly butted and cut to fit around penetrations.
4. Attach sheathing to deck in accordance with roofing manufacturer's recommendations.

B. Vapor Retarder:
1. Install in largest practical widths and lengths.
2. Bond vapor retarder to substrate using approved adhesive.
3. Install continuously at locations indicated.
   a. Coordinate and sequence installation for proper integration with the exterior wall air barrier.
   b. Insure that no discontinuities occur, including at seams, penetrations, and edge terminations.
   c. Join sections of vapor retarder and lap seams in direction of water flow.
   d. Ensure that surfaces to be taped are clean and dry.
4. Seal around pipes, conduits, curbs, safety tie-backs, and other penetrations with pipe boots in accordance with manufacturer's instructions.
5. Maintain continuity of vapor retarder over expansion joints.
6. Repair holes in vapor retarder as recommended by manufacturer.
7. Protect vapor retarder from damage until covered with insulation.

C. Wood Nailers:
1. Install where indicated or required for proper securement of roofing system.

2. Install blocking on top of vapor barrier to thickness required by manufacturer for proper support and attachment.
3. Securement of wood blocking:
   a. Design to resist a minimum of 200 LBS/LF in any direction per SPRI Test Method RE-1.

D. Insulation:
1. Where required thickness of insulation is greater than 2 IN : Install insulation in at least 2 layers.
2. Stagger board joints minimum of 6 IN in successive layers laterally and longitudinally.
3. Butt joints tightly.
4. Cut insulation neatly to fit around roof penetrations and projections.
5. Fill voids greater than 1/4 IN with manufacturer approved spray foam insulation.
6. Secure insulation with approved adhesive.

E. Cover Board:
1. Install cover board continuously over insulation.
2. Offset coverboard joints minimum 12 IN from insulation joints immediately beneath.
3. Secure to substrate in same manner specified for insulation securement.

F. Membrane:
1. Ensure that substrate is clean, dry, free from debris, and smooth with no surface roughness or contamination.
2. Position sheets to accommodate contours of roof deck.
3. Adhering membrane:
   a. Apply bonding adhesive in accordance with manufacturer's published instructions.
   b. Do not apply adhesive in seam areas.
   c. Do not allow adhesive to skin-over or surface-dry prior to installation of membrane.
   d. Unroll roof membrane into the wet adhesive.
   e. Overlap subsequent rolls over previous rolls.
   f. Press each roll firmly into place with a roller in two directions.
   g. Weld cover strips at seams that do not have a factory selvage edge.

G. Heat Welded Seams:
1. Hand welding:
   a. Seam overlaps 4 IN wide.
   b. Complete hand-welded seams in two stages:
      1) Weld back edge of seam with a narrow but continuous weld to prevent loss of hot air during final welding.
      2) Insert nozzle into seam at a 45 degree angle to edge of membrane.
      3) Once proper welding temperature has been reached and membrane begins to flow, position hand roller perpendicular to the nozzle and press lightly.
2. Machine welding:
   a. Comply with membrane manufacturer's instructions.
   b. Machine weld seams 10 FT or longer.
   c. Seam overlaps 3 IN wide.
   d. Utilize metal tracks to minimize wrinkles.
3. Inspect welded seams daily for water tightness and continuity.
   a. Manually probe seams to verify secure weld.
   b. Inspection shall be performed by Technician and verified by Foreman.

H. Membrane Flashing:
1. Adhesively-applied membrane flashings:
   a. Ensure substrates are properly prepared, clean and dry.
   b. Apply flashing adhesive in smooth, even coats and per manufacturer's instructions.
   c. Apply only as much material as can be completed flashed during same day's operations.

d. Press membrane flashing into place and roll with hand roller.
e. Do not apply adhesive to seam areas to be heat welded.
f. Install flashing panels in the same manner, overlapping the edges of panels as required by welding techniques.

2. Stops, bars and cords:
   a. Install Stops, Bars and Cords at locations required by membrane manufacture including:
      1) Base of parapets, walls and curbs.
      2) Base of tapered edge strips and at transitions, peaks, and valleys.
3. Extend flashings at least 8 IN above normal roofing level.
4. Adhere flashing membranes to substrates.
   a. Interior and exterior corners and miters: Cut to fit and heat-weld into place.
   b. Do not use, or allow bituminous products to come in contact with PVC materials.
5. Termination of wall flashings:
   a. Mechanically fastened along counter-flashed top edge with termination bar at 6 to 8 IN OC
   b. Install flashings in accordance with manufacturer's instructions.
   c. Provide additional mechanical securement at flashings extending more than 30 IN vertically.

I. Metal Flashing:
1. Conform to applicable requirements of following:
   a. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
   b. Single Ply Roofing Industry (SPRI) guidelines.
2. Complete metal work in conjunction with roofing and flashings.
3. Make joints watertight.
4. Accommodate normal thermal expansion and contraction.
5. Secure metal flashings to solid wood blocking.
6. Counterflashings:
   a. Overlap base flashing minimum 4 IN .

J. Edge Metal and Coping:
1. Install flashings concurrently with roof membrane as work progresses.
2. Form to profiles indicated and install as indicated.
3. Utilize full length pieces to minimize field splices.
4. Secure to wood nailers.
5. Make joints watertight.
6. Accommodate normal thermal expansion and contraction.

K. Walkways:
1. Install walkways at traffic concentration points, such as roof hatches, access doors, rooftop ladders, or locations as indicated.
2. Do not locate within 10 FT of roof edge.
3. Clean surfaces to be adhered.
4. Adhere pads to membrane per manufacturer's instructions.

L. Protection:
1. When completion of flashings and terminations is not achieved by end of work day, seal system to temporarily prevent water infiltration.
2. Remove temporary water cutoffs prior to proceeding with Work.
3. Remove and replace wet insulation.
4. Protection:
   a. Avoid use of roofing as a walking surface or for equipment movement and storage.
   b. Provide necessary protection and barriers to segregate work and adjacent areas.
   c. Provide plywood over insulation board for roof areas receiving rooftop traffic during construction.

M. Field Quality Control:
   1. Manufacturer's field services:
      a. Provide manufacturer's field service consisting of product use recommendations and a minimum of three site visits for inspection of product installation in accordance with manufacturer's instructions.
   2. Building enclosure commissioning test responsibilities:
      a. Thermal imaging.
      b. Electrical capacitance metering.
      c. FM 1-52 Bonded Uplift.
   3. Repair damage to roof assembly resulting from testing activities.

3.3 SCHEDULE OF ROOF SYSTEMS

A. Roof System 1 - Fully Adhered PVC over Steel Deck:
   1. Sheathing.
   2. Vapor Retarder.
   3. Insulation.
   4. Cover Board.
   5. PVC Membrane, adhered.

B. Roof System 2 - Fully Adhered PVC over Concrete Deck:
   1. Vapor Retarder.
   2. Insulation.
   3. Cover Board.
   4. PVC Membrane, adhered.

END OF SECTION

SECTION 07 62 00
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Flashing and Sheet Metal, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   2. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   3. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate
   4. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
   5. ASTM B308/B308M Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
   6. ASTM F2329/F2329M Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   1. Architectural Sheet Metal Manual

1.3 SUBMITTALS

A. Shop Drawings:
   1. Dimensioned drawings of profiles and shapes.
   2. Plans and elevations to show locations of each shape.

B. Samples:
   1. For finish, color and color range selection.

C. Contract Closeout Information:
   1. Warranty

1.4 WARRANTY

A. Furnish twenty (20) year finish warranty on PVDF coated sheet metal, covering color, fade, chalking and film integrity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Formed Sheet Metal items:
   1. Base:
      a. Ryerson Metals, ColorKlad.
   2. Optional:
      a. Berridge Manufacturing Company.
      b. Petersen Aluminum, PAC-CLAD.

B. Reglets:
   1. Base:
      a. Fry Reglet.

C. Other materials:
   1. Base:
      a. Manufacturers as noted.
   2. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Sheet Metal – Galvanized Steel with PVDF coating.
   1. ASTM A653/A653M galvanized steel, Z275 G90.
   2. Minimum thickness: 0.024 IN or as noted for individual fabrications.
   3. Smooth
   4. PVDF coating: Minimum 1 MIL fluorocarbon coating, 70 PCT PVDF.
      a. Color:
         1) To be selected by Architect from manufacturer's standard line

B. Sheet Metal - Aluminum, PVDF coated:
   1. Sheets and plates: ASTM B209.
   2. Extrusions: ASTM B221.
   3. Minimum thickness 0.05 IN or as noted for individual fabrications.
   4. PVDF coating: Minimum 1 MIL fluorocarbon coating, 70 PCT PVDF.
      a. Color(s):
         1) To be selected by Architect from manufacturer's standard line.

C. Sheet Metal - Stainless Steel:
   1. Type 304 with ASTM-A480 Finish No.4 where exposed.
      a. Type 302 or 304 where concealed.
   2. Minimum thickness: 0.025 IN or as noted for individual fabrications.

2.3 SHEET METAL FABRICATIONS

A. Formed Sheet Metal Copings:
   1. Fabricate to size and profile indicated.
   2. Supply sections with minimum length of 96 IN, but not exceeding 10 FT.
   3. Fabricate joint plates of same sheet thickness as copings.
   4. Securement:
      a. External Leg: Continuous cleats, no exposed fasteners.
      b. Internal Leg: Color-matched fasteners in slotted holes.
   5. Miter corners, seal, and solder or weld watertight.
   6. Joint Style:
      a. 1/4 IN Butt Joint with 6 IN wide, exposed cover plate

Hanging Gutters - Minimum Sheet Thickness / Weight

Material	Gutter Girth			
	up to 20 IN up to 520 MM	**21 to 25 IN** 521 to 650 MM	**26 to 30 IN** 651 to 770 MM	**31 to 35 IN** 771 to 890 MM
PVDF coated Galvanized Steel	0.024 IN 0.61 MM	0.034 IN 0.864 MM	0.040 IN 1.016 MM	0.052 IN 1.132 MM
PVDF coated Galvanized Steel	0.040 IN 1.016 MM	0.050 IN 1.27 MM	0.063 IN 1.6 MM	-
PVDF coated Galvanized Steel	0.019 IN 0.483 MM	0.025 IN 0.635 MM	0.031 IN 0.787 MM	0.038 IN 0.965 MM

B. Downspouts:
   1. Fabricate downspouts to size and profile indicated in minimum 10 FT lengths with section ends formed for minimum 1/2 IN telescoped and locked joints with formed or mitered elbows.
   2. Material: Minimum 0.032 IN aluminum.
   3. Shape: Rectangular.
   4. Downspout supports:
      a. Minimum 0.040 IN thick clips.
      b. Minimum 0.060 IN thick by 2 IN wide leader straps or rack and pin type fasteners.
         1) Use SMACNA standard detail appropriate for downspout.

C. Through Wall Parapet Scuppers:
   1. Fabricate to dimensions indicated with closure flange trim to exterior, 4 IN wide wall flanges to interior, and base extending 4 IN beyond cant or tapered strip into field of roof.

D. Conductor Heads:
   1. Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shapes indicated.
   2. Include outlet tube and exterior flange trim.
   3. Include built-in overflows.
   4. Material: 0.032 IN aluminum.

2.4 ACCESSORIES

A. Fasteners:
   1. Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by flashing manufacturer.
   2. Blind fasteners or self drilling screws, gasketed, with hex-washer head.
   3. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
   4. Blind Fasteners: High strength aluminum or stainless steel rivets suitable for metal being fastened.
   5. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   6. Fastener Materials:
      a. Fasteners for Galvanized Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329/F2320M.

B. Cleats:
   1. 16 GA galvanized or stainless steel.

C. Dissimilar metal and cementitious materials protection:
   1. Alkali resistant bituminous paint.
   2. Tnemec Tneme Tar 46-413.

D. Base Flashing:
   1. Fabricate to size and profile indicated.

E. Counterflashing and Flashing Reglets:
   1. Fabricate to size and profile indicated.
   2. Provide interior and exterior preformed corners as required.
   3. Fabricate as required to fit special conditions.

F. Sealants: Specified in Section 07 92 13.

2.5 FABRICATION

A. General:
   1. Fabricate true and sharp to profiles and sizes indicated.

2. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA Architectural Sheet Metal Manual, that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated.
3. Shop fabricate items to greatest extent possible.
4. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
5. Form sheet metal flashing and trim without oil canning, buckling, and tool marks, true to line and level indicated, with exposed edges folded back to form hems.
6. Conceal fasteners and expansion provisions where possible. Exposed fasteners not allowed on faces exposed to view.

B. Fabrication Tolerances:
1. Fabricate sheet metal flashing and trim to tolerance of 1/4 IN per 20 FT on slope and location lines as indicated and within 1/8 IN offset of adjoining faces and alignment of matching profiles.

C. Sealed Joints: Form movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 IN deep. Fill with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA Architectural Sheet Metal Manual for application, but not less than thickness of metal being secured.

G. Seams in metals with painted, coated or lacquered finishes:
1. Fabricate nonmoving seams with flat-lock seams.
2. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

H. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Verify suitability of substrates to accept work.
1. Verify continuous wood blocking sloped 1:12, and covered with one layer of building paper or roofing membrane.

B. Installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Install in accordance with details and recommendations of SMACNA, current edition.

B. Set shop fabricated interior and exterior preformed corners and intersections.

C. Set top edges of flashings into reglets as indicated.

D. Fasten materials at recommended intervals.

E. Provide slip joints to allow for thermal movement.
1. Use SMACNA Table 3-1, Design J9 - J12, with caulked lap.
2. Maximum spacing: 10 FT on center.
3. Provide slip joint in conjunction with splices and corners.

F. Caulk joints with 2 beads of sealant on each overlap: See Section 07 92 13.

G. Turn down cap flashing over base flashings 4 IN and caulk.

H. Form flashings to provide spring action with exposed edges hemmed or folded.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact, or where sheet metal contacts mortar or concrete.

J. Provide miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weathertight installation.

3.3 INSTALLATION –DOWNSPOUTS

A. Install downspouts supported by leader straps or concealed rack and pin type fasteners at top, bottom and intermediate points not exceeding 5 FT on center.

B. Install downspout 1 IN clear of building wall.

3.4 INSTALLATION – FORMED COPINGS AND FORMED ROOF EDGES

A. Prefabricated corner sections with no joint within 30 IN of corners.

B. Space gutter bars and anchor bolts as recommended by coping manufacturer for installation indicated.

C. Conceal joints with cover plates and top of adjacent wall counter flashing under coping leg.

3.5 CLEAN-UP

A. Upon completion of work, repair damaged areas.

B. Repair finish of PVDF coated flashing which fades or is damaged.

C. Clean stains and debris.

D. Remove protective coverings.

END OF SECTION

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SECTION 07 72 13
MANUFACTURED CURBS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for roof curbs, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

B. National Roofing Council of America (NRCA):
   1. Roofing Manual.

C. American Welding Society (AWS):
   1. Welding codes, specifications, manuals and handbooks..
   2. Qualify welding processes and operations in accordance with AWS Standard Qualification Procedure.

D. Provide Prefabricated Roof Curbing engineered to support dead, live, and lateral (wind or seismic) loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Layout including size, location and type of each curb.
   2. Indicate framing, blocking and anchorage details.
   3. Curb selection shall be coordinated with seismic bracing drawings and details.
   4. Curb anchorage shall be considered part of the equipment and shall be subject to seismic bracing requirements outlined in relevant spec sections.

B. Product Data:
   1. Materials and general construction features of each curb type.

C. Project Information:
   1. Manufacturer's load tables.
   2. Seismic certification where required by AHJ. Coordinate with Division 01 and Section 23 05 48 specifications.
   3. Structural calculations for Prefabricated Roof Curbing indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Prefabricated Roof Curbing:
   1. Base:
      a. Thybar Corporation/ThyCurb.
   2. Optional:
      a. Curbs Plus Inc.
      b. Roof Products, Inc.
      c. Roof Products Systems Corporation (RPS).

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIAL

A. Shell, Liner, and Base:
   1. Galvanized steel ASTM A653, G60.
   2. Thicknesses as indicated for each curb type.
   3. Paint exposed portions in field.
   4. Integral Base Plate.

B. Insulation:
   1. Factory installed 1-1/2 IN thick, 3 PCF density fiberglass.

C. Wood Nailers:
   1. Factory-installed, pressure-treated wood.
   2. Sizes as indicated.

D. Provide splice plates, connector clips and integral crickets as required.

E. Provide sloped transition units as required.

F. Construct curbs in maximum practical lengths, with fully mitered and welded corners at intersections and closed end sections.

G. Roof Curbing:
   1. Prefabricate roof curbs to elevate fans, condensers and other rooftop equipment.
   2. Sizes: As indicated on roof plan.
   3. Material thickness (outer shell & base flange):
      a. Min 0.067 IN (14 GA).
   4. Material thickness (liner):
      a. Min 0.053 IN (16 GA).
   5. Wood nailer: Nominal 2x2.
   6. Internal Reinforcing:
      a. Provide lateral stiffeners at not more than 36 IN OC
      b. Same gauge as outer shell.
   7. Curb Height: Minimum 8 IN from the surface of the roof membrane to top of curb.
   8. Curb Height: As indicated on construction documents
   9. Base product: TC-3 by Thybar Corporation.

H. Roof Curbs Surrounding HVAC Ducts:
   1. Description: Prefabricated roof curbs, as described above, with additional Damper Tray.
   2. See Mechanical Drawings for Fire Dampers & Ducts.

I. Pipe Curb and Cap Assemblies:
   1. Description: Prefabricated roof curb and cap assembly designed to seal around piping, conduit and similar items which pass through roofing.
   2. Base Curb:
      a. Material Thickness (outer shell, base flange, and liner): 18 GA minimum.
      b. Size: 15 IN x 15 IN.

3. Curb Height: Minimum 8 IN from the surface of the roof membrane to top of curb.
4. Curb Height: As indicated on construction documents.
5. Base Product: TC-3 by Thybar Corporation.
6. Curb Cap (top-outlet pipes):
   a. ABS thermoplastic korad acrylic cover, graduated boots molded of weather-resistant Plastisol and 2 stainless steel pipe clamps per boot.
   b. Base Product: TCC-1, TCC-3 or TCC-5 by Thybar Corporation. Contractor to select appropriate cap model for pipe quantity and sizes.
7. Curb Cap (side-outlet pipes):
   a. Sheet metal or ABS cover with horizontally projecting hood flanges.
   b. 2x8 preservative treated wood nailer (vertical) on side where pipes exit.
   c. Base Product: TP-2 by Thybar Corporation.

J. Curb and Solid Cap Assemblies:
1. Description: Prefabricated roof curb and solid cap assembly designed to seal-off a curbed opening for future use.
2. Base Curb:
   a. Material Thickness (outer shell, base flange, and liner): Min 0.042 IN (18 GA).
   b. Size: As indicated.
3. Curb Height: Minimum 8 IN from the surface of the roof membrane to top of curb.
4. Wood Nailer: Nominal 2x2.
5. Base Product: TC-3 by Thybar Corporation.

K. Solid Cap (no penetrations):
1. Definition: Custom sheet metal cap used to cap Curb for future use.
2. Sub-Frame:
   a. Cold-formed steel members designed for roof loads anticipated.
3. Plywood Sheathing: Type:
   a. Preservative-treated, structural grade, CDX or better.
   b. Min Thickness: 3/4 IN.
4. Sheet Metal Cap:
   a. Min 0.042 IN (18 GA) steel.
   b. Uniformly slope to drain.
5. Base Product: custom item by Thybar Corporation.

L. Straight Curbs:
1. Prefabricated roof curbs designed to support and elevate fans, condensers and other roof-top equipment.
2. Curb Lengths and Spacing: As indicated on Roof Plan.
3. Curb Width: Matching width of Nailer.
4. Material Thickness (shell, base flange & counterflashing):
   a. Min 0.067 IN (14 GA).
5. Internal Reinforcing/Gussets:
   a. Provide lateral stiffeners at not more than 36 IN OC
   b. Same gauge as shell.
6. Curb Height: Minimum 8 IN from the surface of the roof membrane to top of curb.
7. Base Product: TEMS-3 by Thybar Corporation.

2.3 RELATED ITEMS – SPECIFIED ELSEWHERE

A. Vibration Isolation Devices: Specified in Section 23 05 50.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which curbs are to be installed for conditions detrimental to proper and timely completion of work.

B. Start of installation constitutes acceptance of responsibility for correct installation and performance.

3.2 INSTALLATION - GENERAL

A. Install units and accessories as indicated.

B. Coordinate installation with decking, roofing, and equipment to be supported.

C. Do not start placement until deck work is complete.

D. Do not overload supporting members.

E. Install metal closure and flashing strips required.

F. Caulk units as required for weather tightness.

G. Provide pedestals and curbs with load carrying capacities adequate for items being supported.

H. Provide roof pedestals for roof-mounted pipe and ductwork.

I. Provide roof pedestals or curbs for roof-mounted equipment.
   1. Use curb only when interior of curb is completely protected from weather by item being supported.

J. Verify attachments have been installed, to both roof construction and supported equipment/components, in accordance with seismic and wind load requirements.

3.3 CLEAN AND TOUCH-UP

A. Wire brush, clean and touch up scarred areas, welds and rust spots.

B. Touch-up damaged galvanized surfaces with galvanizing repair paint.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Firestopping, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:
1. Certified, licensed or approved by firestopping manufacturer, trained to install firestop products per specified requirements.
2. Licensed by State or local authority, where applicable.
3. Shown to have successfully completed not less than 5 comparable scale projects.

B. Provide firestop systems in compliance with following requirements:
1. Obtain firestop system for each type of penetration and construction condition from a single firestop systems manufacturer.
2. Firestop products and systems shall bear classification marking of qualified testing and inspection agency.
3. Firestopping tests, performed by qualified, testing and inspection agency.
   a. UL or other agency, performing testing and follow up inspection services for firestop systems, acceptable to local authorities having jurisdiction.
4. Existing applications for which no tested and listed classified system is available through a manufacturer:
   a. Provide Engineering Judgment or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal derived from similar UL system designs or other tests approved by local authorities having jurisdiction, prior to installation.
   b. Engineering judgment drawings must follow requirements set forth by International Firestop Council.
5. Mold Resistance:
   a. Less than 1 per ASTM G21.
6. Inspect applied firestopping systems in accordance with International Building Code (IBC) Chapter 17.
   a. See Section 01 43 00.

C. UL:
1. UL 263, Fire Tests of Building Construction and Materials
2. UL 723, Surface Burning Characteristics of Building Materials
3. UL 1479, Fire Tests of Through Penetration Firestops
4. UL 2079, Tests for Fire Resistance of Building Joint Systems

D. Underwriters Laboratories (UL) Fire Resistance Directory:
1. Through Penetration Firestop Systems (XHEZ).
2. Joint Systems (XHBN).
3. Fill, Void or Cavity Materials (XHHW).
4. Firestop Devices (XHJI).
5. Forming Materials (XHKU).
6. Wall Opening Protective Materials (CLIV).
7. Fire Resistance Ratings (BXRH)

E. ASTM International (ASTM):
1. ASTM E84 Surface Burning Characteristics of Building Materials
2. ASTM E119 Fire Tests of Building Construction and Materials
3. ASTM E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750F
4. ASTM E814 Fire Tests of Through Penetration Fire Stops
5. ASTM E1399 Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
6. ASTM E1966 Test Method for Fire Resistive Joint Systems
7. ASTM E2174 Standard Practice for On-site Inspection of Installed Fire Stops
8. ASTM E2307 Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using the Intermediate-Scale, Multi Story Test Apparatus (ISMA)
9. ASTM E2393 Standard Practice for On-site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
10. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

F. National Fire Protection Association (NFPA):
1. NFPA 70: National Electrical Code
2. NFPA 101: Life Safety Code
3. NFPA 221: Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls
4. NFPA 251: Fire Tests of Building Construction and Materials

G. Firestop Contractors International Association (FCIA):
1. MOP – FCIA Firestop Manual of Practice

H. International Firestop Council (IFC):
1. Recommended IFC Guidelines for Evaluating Firestop Engineering Judgments, latest revision.
2. Inspectors Field Pocket Guide, latest edition.

I. Identification Labels for Firestop Assemblies:
1. Follow guidelines set in Chapter 7 of International Building Code.
2. Coordinate with Section 04 22 00 and Section 09 29 00.

J. Pipe insulation shall not be removed, cut away or otherwise interrupted at wall penetrations or floor openings.
1. Provide products appropriately tested for the thickness and type of insulation utilized.

K. Cabling where frequent cable moves, additions, and changes are likely to occur in future:
1. Where cable trays are used:
   a. Utilize re-enterable products (e.g. removable intumescent blocks) specifically designed for retrofit.
2. Where cable trays are not used:
   a. Utilize fire rated cable pathway devices.
   b. Where not practical, re-enterable products designed for retrofit may be used.

L. Protect penetrations passing through fire resistance rated floor-to-ceiling assemblies contained within chase wall assemblies with products tested by being fully exposed to fire outside of chase wall.
1. Identify systems within UL Fire Resistance Directory with the words: Chase Wall Optional.

M. Fire-resistive Joint Sealant:
1. Provide flexible fire resistive joint sealants to accommodate normal and thermal building movement without seal damage.
2. Provide fire resistive joint sealants designed to accommodate a specific range of movement.
   a. Test in accordance with cyclic movement test criteria as outlined in: ASTM E1399, ASTM E1966 or UL 2079.

3. Provide fire resistive joint systems subjected to an air leakage test.
   a. Conduct in accordance with UL 2079, with published L-Ratings for ambient and elevated temperatures.
4. Coordinate firestopping with acoustical sealant requirements in Section 07 92 16.

N. Subject smoke wall containment systems to air leakage test.
1. Conduct in accordance with UL 1479, with published L-Ratings for ambient and elevated temperatures.

O. System Description:
1. Through Penetration Firestop Systems for protection of penetrations through following fire resistance rated assemblies, including both blank openings and openings containing penetrating items:
   a. Roof assemblies.
   b. Floor assemblies.
   c. Wall and partition assemblies.
   d. Fire rated smoke barrier assemblies.
   e. Existing, fire and smoke rated assemblies.
   f. Construction enclosing compartmentalized areas.
2. Fire Resistive Joint Assemblies for linear voids where fire rated floor, roof, or wall assemblies abut one another, including following types of joints:
   a. Top and bottom of wall interface with overhead roof or floor structure:
      1) Coordinate with acoustical sealant specified in Section 07 92 16.
      2) Select products to maintain acoustical, smoke and fire ratings indicated.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer's standard information indicating certification of products proposed for use on project.

B. Project Information:
1. UL reports with illustration of systems, system numbers, temperature ratings, and products proposed for use on project.

C. Contract Closeout Information:
1. Warranty.

1.4 WARRANTY

A. Written five (5) year warranty guaranteeing quality of installation and meeting requirements of manufacturer's written instructions and tested systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Firestopping:
1. Base:
   a. Hilti Inc.
2. Optional:
   a. 3M
   b. Rectorseal
   c. Specified Technologies, Inc.
   d. Tremco, Inc.
   e. United States Gypsum Company

B. Forming Materials:
   1. Base:
      a. Hilti Inc.
   2. Optional:
      a. Industrial Insulation Group.
      b. Rock Wool Manufacturing.
      c. Roxul Inc.
      d. Thermafiber

C. Fire Rated Enclosures:
   1. Base:
      a. Tenmat, Inc.
   2. Optional:
      a. EZ Barrier, Inc.

D. Other manufacturers desiring approval comply with Section 01630.
   1. See systems Volume 2 of UL Building Materials Directory.

2.2 MATERIALS

A. Through Penetration Firestop Systems:
   1. VOC content not to exceed 250 g/L.
   2. Base Products:
      a. FS-ONE MAX Intumescent Firestop Sealant.
      b. CFS-S SIL GG Elastomeric Firestop Sealant.
      c. CFS-S SIL SL Elastomeric Firestop Sealant.
      d. CP 620 Fire Foam.
      e. CP 606 Flexible Firestop Sealant.

B. Fire resistive Joints:
   1. VOC content not to exceed 250 g/L
   2. Base Products:
      a. CFS-SP WB Firestop Joint Spray.
      b. CFS-S SIL GG Elastomeric Firestop Sealant.
      c. CFS-S SIL SL Elastomeric Firestop Sealant.
      d. CP 606 Flexible Firestop Sealant.

C. Firestop Devices:
   1. Factory assembled collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
   2. Base Products:
      a. CP 680-P Cast-in-Place Firestop Device.
      b. CP 680-M Cast-in-Place Firestop Device.
      c. CP 681 Tub Box Kit.
      d. CFS-DID Firestop Device.

D. Intumescent Pads, Wall Opening Protective Materials:
   1. Intumescent, non-curing pads or inserts for protection of electrical panels, switch and receptacle boxes, medical gas outlets and valve boxes and other items recessed in face of fire rated walls.
   2. Base Product:
      a. CFS-P PA Firestop Putty Pad.
      b. CP 617 Firestop Putty Pad.
      c. Hilti Biox Insert.

E. Fire Rated Cable Pathways:
   1. Steel raceway and intumescent pads with adjustable smoke seal sleeve.
   2. Fire rating equal to rating of barrier device penetrates.

3. Pathway devices:
   a. Allow 0 to 100 PCT fill of cables.
   b. Adjust automatically to cable additions or subtractions.
4. Size to accommodate quantity and size of electrical wires and data cables indicated plus 100 PCT expansion.
5. Provide cable management devices with gang plates for single or multiple devices.
6. Base products:
   a. CP 653 BA Speed Sleeve.
   b. CFS-SL GP Gangplate.
   c. CFS-SL GP CAP Gangplate Cap.
   d. CFS-CC Firestop Cable Collar.
   e. CFS-SL SK Firestop Sleeve.
   f. CFS-SL RK Retrofit Sleeve.
   g. CFS-COS Composite Sheet.

F. Smoke and Acoustic Cable Pathways:
1. Non-rated steel raceway with adjustable smoke seal polyurethane sleeve for single cables and cable bundles.
2. Re-penetrable and self-closing.
3. Base product:
   a. CS-SL SA Smoke and Acoustic Sleeve.

G. Single Cable and Cable Bundles to 1 IN Diameter:
1. CFS-D Firestop Cable Disc.

H. Firestop Putty:
1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.
2. Provide firestop putty at, but not limited to, the gap between wire, cabling, or both, exiting an open end of conduit, where conduit penetrates one or both sides of a smoke or fire rated wall assembly.
3. Base products:
   a. CP 618 Firestop Putty Stick.
   b. CFS-PL Firestop Plug.

I. Wrap Strips:
1. Single component intumescent elastomeric strips faced on both sides with a plastic film:
2. Base Products:
   a. CP 643N Firestop Collar.
   b. CP 644 Firestop Collar.
   c. CP 648E/648S Wrap Strips.

J. Firestop Blocks and Plugs:
1. Non-curing, flexible intumescent device.
2. Re-enterable.
3. Base products:
   a. CFS-BL Fire Block.
   b. CFS-PL Firestop Plug.

K. Mortar:
1. Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar.
2. Base product:
   a. CP 637 Firestop Mortar.

L. Silicone Sealants:
1. Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces pourable or nonsag or vertical surface nonsag.

2. Base product:
   a. CFS-S SIL GG Elastomeric Firestop Sealant.
   b. CFS-S SIL SL Elastomeric Firestop Sealant.

M. Preformed Mineral Wool:
   1. CP 767 Speed Strips
   2. CP 777 Speed Plugs

N. Fire Sealant:
   1. Single component latex or acrylic formulations that upon cure do not re-emulsify during exposure to moisture.
      a. CFS-S SIL GG Elastomeric Firestop Sealant.
      b. CFS-S SIL SL Elastomeric Firestop Sealant.
      c. CFS-SP WB Firestop Joint Spray.

O. Composite Sheet:
   1. Non-curing, re-penetrable material.
   2. Base Products:
      a. CP 675T Firestop Board.
      b. CFS-BL FireBlock.

P. Forming Materials:
   1. Materials listed as components in laboratory approved designs.
   2. Mineral Wool:
      a. Base Product:SAF by Thermafiber, or
      b. Similar product specifically named as components in laboratory approved designs.

Q. Acoustical Sealant:
   1. Specified in Section 07 92 16.

R. Through Penetration Firestop Systems:
   1. Comply with building code and fire code as locally adopted and amended.
   2. Requirements for single membrane penetrations and through penetration firestops are identical.
      a. Unless otherwise noted, treat penetrants which pass through a single membrane same as though passed through entire fire resistive assembly.
   3. Select each firestop system based on actual field conditions, including penetration type, shape, size, quantities and physical position within opening.
   4. See Drawings for indication of the required ratings of fire resistive wall, floor, and roof assemblies.
      a. Indicated ratings are minimum and may be exceeded.
   5. Firestop assemblies at fire rated walls:
      a. Minimum fire (F) rating for firestop assemblies in walls shall equal that of wall, but not less than 1 HR.
      b. Minimum temperature (T) rating of firestop assemblies in walls may equal zero.
      c. Smoke barrier:
         1) In addition to (F) rating, (L) rating of maximum 5 CUFTM/ SF .
      d. Non-rated walls and smoke partitions with no fire resistive requirement:
         1) Assembly with (L) rating.
   6. Firestop assemblies at fire rated floors and roofs:
      a. Minimum fire (F) and temperature (T) ratings of firestop assemblies used in floors or roof shall equal hourly rating of floor or roof being penetrated, but not less than 1 HR.
         1) Exception 1: T-rating may equal zero when portion of penetration, above or below floor, is contained within a wall.
         2) Exception 2: Firestops are not required for floor penetrations within a 2-hour rated shaft enclosure.

S. Voids in Wall with No Penetrations:
   1. Fill with approved through penetration firestopping system.
   2. Contractor's option: Patch void in wall with like construction.

T. Penetrating Ducts with Dampers:
   1. Utilize only firestop materials which are included in damper's classification.
   2. Do not install firestop systems that hamper performance of fire dampers.

U. Cable Trays and Similar Devices:
   1. Provide re-enterable products specifically designed for removal and re-installation at openings within walls and floors designed to accommodate voice, data and video cabling.

V. Electrical panels and devices, medical gas outlets and valve boxes, film illuminators, and other items recessed in to face of rated walls:
   1. Where electrical devices are placed on opposite sides of wall, and are less than 24 IN apart measured horizontally, install intumescent pads over back of devices in approved manner or maintain continuity of rated barrier within wall cavity surrounding recessed item.

W. Fire Resistive Joint Assemblies:
   1. Where joint will be exposed to elements, fire resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C920.
   2. Head of Wall Assemblies:
      a. Use at top of fire rated and smoke barrier walls and partitions where they abut floor and roof structures above.
      b. Select systems with D designation, rated for dynamic movement capability.
      c. Select systems that can accommodate deflection of structure above.
      d. Maximum Leakage for Fire resistive Joints in Smoke Barriers: 5 CUFTM or less per linear foot as tested in accordance with UL 2079.
      e. Seal non-fire rated sound control walls and smoke partitions with acoustical sealant as specified in Section 07 92 16.
   3. Minimum F and T ratings:
      a. The minimum fire rating for firestop assemblies in walls shall equal that of wall, but not less than 1 HR.
      b. The minimum temperature rating of firestop assemblies in walls may equal zero.
   4. Acceptable Systems:
      a. Metal stud and drywall partitions: Select system from UL HW-D-0000 Series.
         1) For metal stud partitions installed on flat concrete slab use one piece, pre-formed polyurethane foam firestop seal designed for use with standard head joint top tracks and bottom joint tracks or slip-type head joints to maintain continuity of the fire resistance rated assembly indicated.
         2) Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle over the top track or under the bottom track.
      b. Concrete and Masonry Walls: Select system from UL HW-D-1000 Series.

X. Fire Rated Enclosures:
   1. Provide where required as part of a UL Fire Resistance Directory design for fixtures mounted in rated walls or ceilings.
      a. Field constructed enclosures meeting Fire Resistance Directory designs will be accepted.
   2. Include accessories and install according to enclosure manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install firestop systems in accordance with manufacturer's instructions and conditions of testing and classification as specified in UL or other acceptable third party testing agency listing.

B. Penetrations through fire resistive floor assemblies shall be sealed with firestop system providing minimum Class 1 W-rating as tested in accordance with UL 1479 and ensure air and water resistant seal.

C. Protect materials from damage on surfaces subjected to traffic.

D. Identification Labels:
1. Identify each firestop assembly as defined in Quality Assurance.
2. Do not locate identification labels, tags, or both, on finished surfaces or where exposed to view by public.

3.3 FIELD QUALITY CONTROL

A. Maintain areas of work accessible until inspection by authorities having jurisdiction.

B. Where deficiencies are found, repair or replace assemblies to comply with requirements.

3.4 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean surfaces adjacent to sealed openings free of excess materials and soiling as work progresses.

C. Perform patching and repair of firestopping systems damaged by other trades.

END OF SECTION

SECTION 07 92 13
EXTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Exterior Joint Sealants, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Caulk and Caulking are synonymous with sealant work.

B. Paving Joints include joints in floor slabs, sidewalks, steps, ramps and curbs.

C. Seal joints which would otherwise permit penetration of moisture or air, unless sealant work is specifically required under other Section.

D. Provide sealant at following locations:
1. Flashing reglets and retainers.
2. Exterior wall joints.
3. Masonry control joints, and between masonry and other materials.
4. Isolation joints.
5. Joints between paving or sidewalks and building.
6. Joints at penetrations of walls, floors and decks by piping and other services and equipment not requiring firestopping.
7. Perimeters door and window frames, louvers, grilles, etc.
8. Joints between dissimilar materials, to provide visually acceptable closures.
9. Solidly bed thresholds at exterior doors.
10. Other joints where caulking, or sealant is indicated.
11. Joints where Pre-molded Compressible Sealants is indicated.

E. Related materials specified elsewhere:
1. Interior Joint Sealants: See Section 07 92 16.
2. Firestopping: Specified in Section 07 84 00.

F. ASTM International (ASTM):
1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
2. ASTM C920 Standard Specification for Elastomeric Joint Sealants
3. ASTM C1193 Standard Guide for Use of Joint Sealants

1.3 SUBMITTALS

A. Shop Drawings:
1. Sealant Schedule with the following information:
   a. Generally describe locations requiring sealants (i.e. Brick to Aluminum Window).
   b. List type of sealant and name of product proposed for each location.
   c. Include a blank Color Column on schedule for selection.
   d. Architect to complete Color Column upon selection from submitted samples.

B. Product Data:
1. Performance characteristics and limitations.
2. Recommended installation.

C. Samples:
   1. Cured sample of each color. Submit with Sealant Schedule.

D. Contract Closeout Information:
   1. Warranty.

1.4 WARRANTY

A. Provide written warranty that sealant work will remain free of defects for a period of three (3) years from Date of Substantial Completion:
   1. Failure of water or air tightness constitutes defect.
   2. Loss of adhesion, cohesion or failure to cure constitutes defect.
   3. Remove defective work and materials and replace with new work and materials.
   4. Repair other work damaged as a result of defective sealant work at no additional expense to Owner.
   5. Non- prorated warranty to include labor and material.
   6. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Silicone Sealant:
   1. Base:
      a. Tremco.
      b. Dow Corning.
   2. Optional:
      a. Pecora.
      b. GE Silicone by Momentive Performance Materials.
      c. BASF Master Builders Solutions.
      d. Bondaflex Technologies.

B. Polyurethane Sealants:
   1. Base:
      a. Tremco.
   2. Optional:
      a. Pecora.
      b. BASF Master Builders Solutions.
      c. Sika.
      d. Bondaflex Technologies.

C. Silyl Terminated Polyether (STPE) Sealant:
   1. Base:
      a. BASF Master Builders Solutions.
   2. Optional:
      a. Pecora.
      b. GE Sealants by Momentive Performance Materials.

D. Other Sealants:
   1. Base: As indicated.

2.2 MATERIALS

A. Elastomeric Sealants:
   1. ASTM C920 Type S or M, Grade-NS, minimum Class 25.
   2. Non-staining sealant complying with ASTM C510.
   3. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
   4. Use non-sag sealant in vertical joints.

5. Use self-leveling or non-sag sealant in horizontal joints.
6. Before use of sealant, investigate its compatibility with surfaces, fillers and other materials in joint system.
7. Refer to Sealant Selection Guide for Base Products.
8. Comply with VOC limits as required by local laws.
9. VOC content no greater than 250 g/L.

B. Pre-molded Compressible Sealant:
1. Pre-finished.
2. Foam backing: Multiple layers of acrylic-impregnated, expanding foam sealant.
3. Weather Facing: Low-modulus silicone with bellows profile.
4. Movement capability: +/-25 PCT movement, 50 PCT total.
5. Material to be sized appropriately for joint widths indicated.
6. Base Product: ColorSeal by Emseal.

C. Compressible Backer:
1. Foam backing with multiple layers of acrylic-impregnated, expanding foam sealant.
2. Provide behind conventional backer-rod and sealant where indicated.
3. Movement capability: +/- 25 PCT movement, 50 PCT total.
4. Material to be sized appropriately for joint widths indicated.
5. Base Product: Backerseal by Emseal.

D. Installation Adhesive:
1. As recommended by manufacturer of compressible sealants and backers.
2. Comply with VOC limits as required by local laws.

E. Joint Cleaner, Primer, Bond Breaker:
1. As recommended by sealant manufacturer.

F. Backer Rod:
1. Polyethylene, polyethylene jacketed polyurethane foam, flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation of joint sealants under following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 DEGF.
2. When joint substrates are wet.

B. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Apply only to joints free of material which may inhibit bond.

D. Apply to cementitious materials only when thoroughly cured and dry.

3.2 PREPARATION

A. Clean joints and prime as required by sealant manufacturer.

B. Install sealant after finish coating or covering is scheduled to be applied.

C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.3 INSTALLATION

A. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Control joint depth.
   2. Break bond of sealant at bottom of joint.
   3. Provide proper shape of sealant.
   4. Do not leave gaps between ends of sealant backings.
   5. Do not stretch, twist, puncture, or tear sealant backings.
   6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

B. Make depth of sealant not more than one-half width of joint, but not less than 1/4 IN.

C. Sub-caulk joints without suitable backstop, to proper depth.

D. Install correctly sized backer rods.

E. Apply bond breaker as required or recommended by sealant manufacturer.

F. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

G. Make joints water and air tight.

H. Install sealants using proven techniques that comply with the following and at same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

I. Tooling of Non-sag Sealants:
   1. Tool immediately after sealant application and before skinning or curing begins, to form smooth, uniform beads, eliminate air pockets, and ensure contact and adhesion of sealant with sides of joint.
   2. Remove excess sealant adjacent to joints as the Work progresses with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
   3. Use tooling agents that are approved by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   4. Provide concave joint profile per Figure 8A in ASTM C1193, unless otherwise indicated.

J. At traffic joints, slightly recess sealant to avoid direct contact with wheeled traffic.

3.4 SEALANT USAGE GUIDELINES

Guide to Sealant Types - Exterior

Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
General Exterior	Cast in Place Concrete	Multi-part Polyurethane, chemically curing, epoxidized	Tremco Dymeric 240FC	Exception: Use Dymonic where used as bedding sealant for frames, sills, thresholds etc.
	Brick and Concrete Masonry			
	Portland Cement Plaster			
	Hollow Metal Door and Window Perimeters			
	Aluminum Composite Panels (ACM) and Metal Column Covers	Silyl Terminated Polyether (STPE)	MasterSeal NP150	--
	Joints in materials with high coefficients of linear expansion			

Guide to Sealant Types - Exterior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
	Weatherseals of Aluminum Window Frames (including perimeter joints)			
	Precast Concrete Panels	Silicone or Silyl Terminated Polyether (STPE)	Tremco Spectrem 1 or Spectrem 3 or MasterSeal NP150	--
	EIFS Systems			
	Stone Work	Silicone or Silyl Terminated Polyether (STPE)	Tremco Spectrem 3 or MasterSeal NP150	Exception: Pre-test for staining potential per ASTM C1248, with stain-sensitive stone Note: MasterSeal will not stain.
	General Exterior Glazing	Silicone; Neutral-cure	Tremco Spectrem 2 or Proglaze	Exception: Select alternate silicone sealant types as appropriate for specific glazing application.
	Butt Glazing and Structural Silicone Joints	Silicone; 1-part, Neutral-cure	Dow Corning 795	--
	Fabrication of Insulating Glass Units (IGU)	Primary Seal: Polyisobutylene	Select high quality sealants, of basic type listed, as appropriate for specific application.	
		Secondary Seal: Silicone	Dow Corning 982	--
	Zone dams, shear blocks and other internal component of Aluminum Window Systems	Silicone	Use product which offers optimal adhesion and performance for application.	
	Sheet Metal Gutters, Downspouts, Scuppers, etc	Synthetic Rubber-Resin, elastomeric	Tremco Gutter Sealant	--
	Existing joints where Silicone was previously used	Silicone	Use product which offers optimal adhesion and performance for condition, and which offers suitable color choices for matching.	
Exterior Flatwork	Concrete Paving and Parking Structures	Multi-part Polyurethane	Tremco THC 900 / 901	Exception: Where subject to continual water emersion; use Vulkem 45 or 245
	Concrete Walks			
	Brick Paving and Walks			
	Stone and Precast Plazas			
Detention Facilities				
Building Exterior	Door and Window Frame Perimeters	Epoxy	Sikadur 31	Flexible Epoxy above 10 FT AFF
	Electrical Fixtures			
Group Yards and Management Yards	Plumbing and Electrical Fixtures	Epoxy	Sikadur 31	Flexible Epoxy above 10 FT AFF
	Furnishings and Fixed Equipment			

Notes
1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed.
3. All of the conditions and materials listed may not apply to subject project.

END OF SECTION

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SECTION 07 92 16
INTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Interior Joint Sealants, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Definitions:
   1. Caulk and Caulking are synonymous with sealant work.
   2. Interior Wet Areas includes toilets, showers, kitchens and similar areas where sealant is subject to moisture.

B. Seal joints which permit penetration of moisture or air, unless sealant work is specifically required under other sections.

C. Provide sealants at the following:
   1. Masonry control joints, and between masonry and other materials.
   2. Flooring joints.
   3. Isolation joints.
   4. Joints at penetrations of walls, floors and decks by piping and other services and equipment not requiring firestopping.
   5. Perimeters of door and window frames, louvers, grilles, etc.
   6. Between cabinets, casework, countertops and back splashes where adjacent to walls.
   7. Joints between dissimilar materials, to provide visually acceptable closures.
   8. Other joints where caulking, or sealant is indicated.

D. ASTM International (ASTM)::
   1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
   2. ASTM C711 Standard Test Method for Low-Temperature Flexibility and Tenacity of One-Part, Elastomeric, Solvent-Release Type Sealants
   3. ASTM C719 Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement
   4. ASTM C792 Standard Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
   5. ASTM C793 Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
   6. ASTM C910 Standard Test Method for Bond and Cohesion of One-Part Elastomeric Solvent Release-Type Sealants
   7. ASTM C920 Standard Specification for Elastomeric Joint Sealants
   8. ASTM C1193 Standard Guide for Use of Joint Sealants

E. South Coast Air Quality Management District (SCAQMD), Rule #1168.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Sealant Schedule with the following information:
      a. Generally describe locations requiring sealants (i.e., GWB to Aluminum Window).
      b. List type of sealant and name of product proposed for each location.

c. Include a blank Color Column on schedule for selection.
d. Architect to complete Color Column upon selection from submitted samples.

B. Product Data:
1. Performance characteristics and limitations.
2. Recommended installation.

C. Samples:
1. Submit cured sample of each color with Sealant Schedule.

D. Contract Closeout Information:
1. Warranty.

1.4 WARRANTY

A. Provide written warranty that sealant work will remain free of defects for a period of three (3) years from Date of Substantial Completion:
1. Failure of water or air tightness constitutes defect.
2. Loss of adhesion, cohesion or failure to cure constitutes defect.
3. Remove defective work and materials and replace with new work and materials.
4. Repair other work damaged as a result of defective sealant work at no additional expense to Owner.
5. Non- prorated warranty to include labor and material.
6. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Polyurethane Sealants:
1. Base:
a. Tremco
2. Optional:
a. Pecora
b. Sonneborn/ChemRex
c. Sika
d. Bondaflex Technologies

B. Silicone Sealants:
1. Base:
a. As noted for individual items.
2. Optional:
a. Bondaflex Technologies
b. Color Rite
c. Dow Corning
d. GE Silicones
e. Pecora
f. Sonneborn/ChemRex
g. Tremco

C. Acoustical Sealant:
1. Base:
a. Hilti
2. Optional:
a. Grabber
b. Pecora
c. STI
d. 3M

D. Other Sealants:
   1. Base: As indicated.

E. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. General:
   1. ASTM C920 Type S or M, Grade-NS, minimum Class 25.
   2. Non-staining sealant complying with ASTM C510.
   3. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
   4. Use non-sag sealant in vertical joints.
   5. Use self-leveling or non-sag sealant in horizontal joints.
   6. Before use of sealant, investigate its compatibility with surfaces, fillers and other materials in joint system.

B. Volatile Organic Compounds (VOC):
   1. Comply with South Coast Air Quality Management District (SCAQMD), Rule 1168.
      a. Sealants: 250 g/L.
      b. Sealant Primers for Nonporous Substrates: 250 g/L.
      c. Sealant Primers for Porous Substrates: 775 g/L

C. Elastomeric Sealant:
   1. Refer to Sealant Selection Guide for types required.
   2. Comply with VOC limits as required by local laws or specified otherwise.

D. Casework Sealant:
   1. Solid Colors.
   2. 100 PCT silicone.
   3. Color-Sil by Color Rite

E. Acoustical Sealant:
   1. Flexible, non-hardening.
   2. UL listed.
   3. Seal perimeter of sound rated partitions.
   4. Seal perimeter and cover outside faces of electrical boxes and similar utilities in sound rated partitions.
   5. Base Products:
      a. Gun - CP 506 by Hilti
      b. Spray – CP 572 by Hilti

F. Joint Cleaner, Primer, Bond Breaker:
   1. As recommended by sealant manufacturer.

G. Backer Rod:
   1. Polyethylene, polyethylene jacketed polyurethane foam, flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation of joint sealants under following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 DEGF .
   2. When joint substrates are wet.

B. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Apply only to joints free of material which may inhibit bond.

D. Apply to cementitious materials only when thoroughly cured and dry.

3.2 PREPARATION

A. Clean joints and prime as required by sealant manufacturer.

B. Install sealant after finish coating or covering is scheduled to be applied.

C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.3 INSTALLATION

A. Install sealant backings to support sealants during application.
   1. Control joint depth.
   2. Break bond of sealant at bottom of joint.
   3. Provide proper shape of sealant.
   4. Do not leave gaps between ends of sealant backings.
   5. Do not stretch, twist, puncture, or tear sealant backings.
   6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

B. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

C. Install sealants using proven techniques that comply with the following and at same time backings are installed:
   1. Place sealants to directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths allowing optimum sealant movement capability.

D. Prime joint surfaces as recommended by sealant manufacturer for conditions:
   1. Limit application to surfaces to receive sealants.
   2. Mask off adjacent surfaces.

E. Sub-caulk joints without suitable backstop, to proper depth.

F. Tool sealants using sufficient pressure to fill voids.

G. Remove excess sealant adjacent to joints.

H. Hollow Metal Frames:
   1. Seal frames to wall.
   2. Seal frames to floor substrates and hard floor finishes.
   3. Do not seal frames to previously installed carpet and similar finishes.
   4. Seal hairline gaps where stops and rabbets of frame members intersect.

I. Acoustical Sealant:
   1. General:
      a. Apply acoustical sealant at joints, voids, and penetrations through wallboard to maximize sound control.
         1) Seal wallboard edges to adjacent construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant.
         2) Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
         3) Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

b. Refer to Section 07 84 00 for firestopping of through-wall penetrations.
   1) Provide firestop sealant where required in fire-rated assemblies.
1. Base of walls:
   a. Apply acoustical sealant to bottom edge of gypsum wallboard at floor.
2. Head of walls:
   a. Apply acoustical sealant to top edge of gypsum wallboard at building structure.

3.4 SEALANT USAGE GUIDELINES

Guide to Sealant Types - Interior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
Interior (General)	Window Sills / Stools	100 PCT silicone	Color-Sil Poly-Sil	--
	Cabinets and Casework to wall			
	Countertops and Backsplashes			
	Sinks in Countertops			
	Interior Alum Doors and Window Frame Perimeters	Multi-part, chemically curing Polyurethane	Tremco Dymeric 240FC	--
	Non-rated wall, floor and deck penetrations.			
	Hollow Metal Door and Window Frames	Siliconized Acrylic Latex (paintable)	Tremco Tremflex 834	Exception: Where sealant will not be subsequently painted and white color will not be visually compatible with adjacent finishes: Use Dymeric 240FC of matching color.
	Acoustical Sealant Joints at top and bottom terminations of Interior Walls	Acrylic	Hilti CFS-SP WB	--
		Silicone	Hilti CP 601S	
Interior Flatwork	Control Joints in Concrete Floors in Mechanical Rooms and other un-finished spaces	Multi-part Polyurethane	Tremco THC 900 / 901	Exception: Where subject to continual water emersion; use Vulkem 45 or 245
	Stone and Precast Flooring			
Interior Wet Areas	Porcelain, Ceramic Tile, Metals, and surfaces with Epoxy Paints	Silicone; Air cure	Tremco Tremsil 200	--
Detention Facility Secure Areas (Cells, Housing Units, Day Rooms, Inmate side of Visiting and Interview Rooms and where indicated)	Door and Window Frame Perimeters, Sills and Stools	Epoxy	Sikadur 31	Construction joints and items fastened to wall, ceiling and floor less than 10 FT AFF
	Cabinets and Casework to wall			
	Sinks, Countertops and Backsplashes			
	Plumbing Fixtures, Electrical Fixtures and Fixed Equipment			
	Porcelain, Ceramic Tile, Metals, and surfaces with Epoxy Paints			
	Control Joints in Concrete Floors and other hard surface Flooring	Epoxy	Sikadur 31	Do not use at expansion joints or joints covered by another floor material

Guide to Sealant Types - Interior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
	Materials in Secure Areas listed above	Flexible Epoxy	Sikadur 51	Use 10 FT AFF and above for all locations where Epoxy is listed
Laboratories	Sanitary seal at joints between ceramic and prefinished surfaces	Sanitary Silicone	Tremco Tremsil 200	White only
	Sanitary seal at joints between epoxy painted and prefinished surfaces	Sanitary Silicone	Pecora 898	White only
	Airtight seal at openings in walls and ceilings	Structural Silicone	GE SilPruf SCS2000	Includes electrical conduits
		Heat Shrink Polyolefin Tubing	NP-700md	
Clean Zone / Cleanrooms	Cleanroom Sealant	Polyurethane	Sikaflex-1A Or Dow Corning 6-1125 CV	White only

Notes
1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed.
3. All of the conditions and materials listed may not necessarily apply to subject project.
4. Not all project conditions may be addressed on above table; Refer also to other specification sections and install sealants where called for by other sections.
5. Materials and Conditions conventionally occurring on Exterior but used on Interior (e.g., Brick Masonry on interior) may not be listed on this Table. Refer to Exterior Guide (Section 07 92 13) for appropriate sealant type.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL (HM) DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Hollow Metal Doors and Frames in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A568 Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled

B. Hollow Door and Frame Standards:
   1. ANSI A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
   2. ANSI A250.8 / SDI 100 Recommended Specifications for Standard Steel Doors and Frames
   3. ANSI A250.11 Recommended Erection Instructions for Steel Frames

C. Fire Rated Doors and Frames:
   1. Label and list for ratings indicated by ITS – Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
   2. Affix physical label or approved marking to fire door or fire door frame at an authorized facility as evidence of compliance with procedures of labeling agency.
   3. Where pairs of doors require fire rating (90 minute maximum), doors shall have passed appropriate test without the use of astragals.
   4. Positive Pressure:
      a. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.

D. Smoke and Draft Control Assemblies:
   1. Maximum Leakage: 3 CUFTM per SF of door face area when tested at pressure of 0.10 IN water per UL 1784.
   2. Applicability:
      a. Doors in Smoke Barriers and fire-rated Corridor walls.
      b. Doors forming part of an Elevator Lobby enclosure.
   3. Provide S-Labels on smoke and draft control openings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Use same reference numbers for openings as those in Door and Frame Schedule in Drawings.
   2. Indicate door elevations, gauges; frame configuration; anchor types and spacing; location of reinforcement and preparations for hardware, including items recessed within door edges; details of moldings, removable stops, glazing and louvers; details of conduit and preparations for power, signal, and control systems.

B. Product Data:
   1. Include construction details, material descriptions, core descriptions, fire resistance rating and finishes.
   2. Shop primer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hollow Metal Doors and Frames:
   1. Base:
      a. Curries
   2. Optional:
      a. Ceco Door Products
      b. Philipp Manufacturing Company
      c. Republic Doors and Frames
      d. Steelcraft Manufacturing

B. Galvanizing Repair Coating:
   1. Base:
      a. Tnemec
   2. Optional:
      a. ZRC Worldwide
      b. SherwinWilliams

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Steel Sheet and Strip:
   1. Comply with ASTM A568.

B. Corrosion Resistant Coating:
   1. Standard:
      a. Hot dip galvannealed: A60 per ASTM A653.
      b. Minimum zinc-iron alloy coating: 0.6 OZ/FT2 .
   2. Provide above corrosion resistant coating at door and frame components where used at wet and humid locations as defined by following:
      a. Openings located in an exterior wall.

C. Primer:
   1. Shop prime.
   2. Clean and phosphatize doors and frames.
   3. One coat of baked-on rust inhibiting primer paint in accordance with ANSI A250.10.
   4. Suitable and compatible as base for specified finish paints.

D. Galvanizing Repair Coating:
   1. Galvanized coating repair.
   2. VOC 250 g/L maximum.

E. Hollow Metal Doors:
   1. Comply with ANSI/SDI A250.8.
   2. Determination of performance level for each door:
      a. Use level of HM door indicated for its location, size and other listed criteria.

Schedule of HM Door Levels

Location	Additional Criteria	HMMA Level	Miscellaneous
Exterior Doors [1] (flush)	Openings where each leaf is less than 47 IN	Level 3 (Extra Heavy duty)	Galvanized / galvannealed, Thermally Insulated
	Openings where one or more of the leaves exceeds 47 IN	Level 4 (Maximum-duty)	
Exterior Doors [1] (stile and rail)	All	Level 3 (Extra Heavy duty)	Galvanized / galvannealed, Thermally Insulated

Schedule of HM Door Levels			
Location	Additional Criteria	HMMA Level	Miscellaneous
	[2]		
Interior Doors	Non-fire rated	Level 3 (Extra Heavy duty)	--
	Fire rated	Level 3 (Extra Heavy duty)	Labeled as indicated (w/out astragal wherever possible)
	Wet / Humid Areas [2]	Level 3 (Extra Heavy duty)	Galvanized / galvannealed; Moisture-resistant core - Fire resistant were required

Notes
Refer to Door Schedule for indication of the Door Type (I.e. Width, Fire Rating, Flush vs. Stile & Rail, etc.)
Refer to Plans for door location (Exterior vs. Interior).
Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate door/frame construction.
Not all items included in table may apply to subject project.

Footnotes
1. Refer to Part 2.2 MATERIALS for definition of Exterior locations.
2. Refer to Part 2.2 MATERIALS for definition of Wet/Humid locations.

3. Door Thickness: 1-3/4 IN .
4. ANSI A250.8 Level 3, Extra Heavy duty, physical performance Level A.
   a. Face Sheet Thickness: 0.053 IN (16 GA) .
5. ANSI A250.8 Model 2, Seamless.
6. End closures at top and bottom of door:
   a. Top: Flush closure top cap. Minimum Sheet thickness: 0.032 IN (20 GA)
   b. Bottom: Flush closure. Minimum Sheet thickness: 0.032 IN (20 GA) .
   c. Bottom: Inverted channel. Minimum Sheet thickness: 0.053 IN (16 GA) 1.3 MM.
7. Vertical door edges:
   a. Lock Stile Edges: Beveled 1/8 IN per 2 IN .
      1) Exception for inactive leaves: Fabricate inactive leaves with a square edge at the lock stile edge. Active leaves to be beveled per above.
      2) Hinge Stiles Edge: Beveled 1/8 IN per 2 IN .
      3) Exceptions for Double Acting Doors: Provide convex, radiused edges at lock stiles and hinge stiles.
8. Hardware Reinforcement (doors):
   a. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as door face sheets.
   b. Minimum thickness: As prescribed in ANSI/SDI A250.6; Upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
   c. Butt Hinges: 0.167 IN (7 GA) .
   d. Continuous hinges: Reinforce with 0.067 IN (14 GA) thick x 1-1/4 IN wide strapping extending full height and welded to hinge edge of door.
   e. Closers and Overhead Stops: 0.067 IN (14 GA) .
9. Cores:
   a. Steel stiffeners where structurally required.
   b. Exterior Doors:
      1) Thermally insulated core.
         a) 1.0 LBS/CFPolystyrene.
         b) Minimum R-value: 2.0 when tested according to ASTM C1363.
   c. Interior doors:
      1) Non-rated doors: Kraft honeycomb laminated to face sheets.
      2) Rated doors: Fire resistant core as required by label.
      3) Wet/humid Areas: Moisture resistant materials, fire resistant where applicable.

d. Specific materials used for above listed core types: Manufacturer's option.
e. Reinforce for Hardware.

F. Hollow Metal (HM) Frames:
1. Comply with ANSI/SDI A250.8 and with details indicated for type and profile in accordance with SDI 111.
2. Fabricate frames with mitered or coped corners and 1/2 IN nominal backbend.
a. Provide extended backbend at wall tile applications as detailed in drawings.
b. Touch-up galvanized/galvannealed frames with zinc-rich primer.
3. Fabricate frames as Face Welded (modified ANSI definition):
a. Face Joints: Continuously back weld face joints (weld on concealed side).
1) Fill and finish exposed sides to be free of visible seams.
b. Intersections of Rabbets, Stops and Soffit Joints: Fabricate to hairline joints. Stitch weld on concealed side.
c. Split type frames and knock down type frames are not acceptable.
d. Fasteners which are exposed to view are not acceptable.

Schedule of HM Frames

Location	Criteria	Minimum Thickness	Miscellaneous
Exterior Frames [1]	Standard and Thermally Enhanced	0.067 IN (14 GA)	Galvanized / galvannealed
Interior Frames [1]	Non-fire rated	0.053 IN (16 GA)	--
	Fire rated	0.053 IN (16 GA)	--
	Frames for doors with automatic openers	0.067 IN (14 GA)	--
	Wet / Humid Areas [2]	0.053 IN (16 GA)	Galvanized / galvannealed

Notes
Gauge of frame listed is the minimum. Use heavier gauge as required due to size, physical configuration or if required to meet fire label requirements.
Refer to Door Schedule for indication of the Frame Type (I.e. Width, Single vs. Pair; Fire Rating, etc)
Refer to Plans for door location (Exterior vs. Interior).
Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate door/frame construction.
Some items listed may not apply to subject project.

Footnotes
1. Refer to Part 2.2 for definition of Exterior locations.
2. Refer to Part 2.2 for definition of Wet/Humid locations.

4. Hospital stops:
a. Provide where indicated.
b. Cut and fully weld.
c. Height from floor: 4-1/2 IN .
d. 45 degree bevel termination at bottom of stop.

G. Light Kits:
1. Label for intended opening.
2. Fixed Stop:
a. Locate at exterior face.
b. Integral to door/frame.
3. Removable Stop:
a. Locate on interior face.
b. Snap-in stops or stops secured with countersunk Phillips head machine screws.

H. Silencers:
1. Specified in Section 08 71 00.

2. Quantity:
   a. Three on strike jamb of single frames.
   b. Two per door for pair doors. Locate at head.
3. Space per manufacturer's recommendations.
4. Use plastic plugs to keep holes clear during construction.

I. Hardware Reinforcement:
1. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
2. Minimum thickness: As prescribed in ANSI/SDI A250.6; upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
   a. Butt Hinges: 7 GA.
   b. Continuous hinges: Reinforce with 0.067 IN (14 GA) thick x 1-1/4 IN wide strapping extending full height and welded to hinge jamb door rabbet of frame.
   c. Closers and Overhead Stops: 0.093 IN (12 GA) thick x 12 IN long strapping welded to vertical flange of frame.

J. Head Stiffeners:
1. Provide at double egress frames:
2. Position stiffeners at mid span of frame opening.

K. Junction Boxes:
1. Sheet metal enclosure:
   a. Provide to facilitate pulling of wires and making electrical connections.
   b. Weld to back side of frames.
2. Material: 0.032 IN (20 GA) sheet steel.
3. Size and shape: As required by hardware device.
4. Include knockout to receive 1/2 IN conduit.
5. Locate Junction Boxes in frames scheduled to receive electrified security, door hardware devices, or both.

L. Jamb Anchors:
1. ASTM A879 Commercial Steel, 4 OZ/SF coating; mill phosphatized.
   a. Frames in exterior walls:
      1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
2. Provide anchors in accordance with manufacturer's recommendations on fire rated doors.
3. Provide minimum number as indicated in following table:

Minimum Quantity of Jamb Anchors	
Nominal Frame Height	Minimum Quantity per Jamb
Less than 60 IN 1.5 m	2
60 IN to 90 IN 1.5 M to 2.3 m	3
90 IN to 120 IN 2.3 M to 3 m	4
120 IN to 150 IN 3 M to 3.8 m	5
Greater than 150 IN 3.8 m	Add 1 additional for each 30 IN increase in height thereafter

   a. Jamb anchors for stud framed walls:
      1) Z-shaped clips, welded to inside of frames; not less than 0.042 IN (18 GA) thick, or compression anchors to suit frame size.
      2) Attach anchors to studs with screws.
   b. Jamb anchors for masonry walls:
      1) Adjustable strap-and-stirrup or T-shaped anchors to suit frame size.
      2) Minimum 0.042 IN (18 GA) .

3) Corrugated or perforated straps:
   a) Minimum 2 IN wide by 10 IN long.
4) Wire anchors:
   a) Minimum 0.184 IN (6 GA) thick.
5) Embed long leg into masonry wall as units are placed.
6) Post installed expansion type for in place concrete or masonry:
   a) Minimum 3/8 IN countersunk, flat head expansion bolts with expansion shields or inserts.
   b) Include pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   c) Minimum embedment length: 1-3/4 IN .

c. Floor Anchors:
1) Same for Jamb Anchors but not less than 0.053 IN (12 GA) thick.
   a) Anchors built into exterior walls:
      (1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
   b) Monolithic concrete slabs:
      (1) Clip type anchors, with two holes to receive fasteners.
   c) Topped slabs:
      (1) Adjustable anchors with extension clips allowing not less than 2 IN height adjustment. Terminate bottom of frames at finish floor surface.
2) Include concealed fasteners.
3) Provide anchors in accordance with manufacturer's recommendations at fire rated openings.

d. Head Anchors for Double Egress Frames:
1) Provide two head frame anchors for Double Egress frames.
2) Locate at third points of span.

4. Spreaders:
   a. Provide removable spreaders at bottom of door frames.
5. Inserts, bolts and fasteners:
   a. Manufacturer's standard units
   b. Galvanize items built into exterior walls ASTM A153, Class C or D as applicable.

2.3 FABRICATION

A. Factory fit doors to frame openings with uniform clearances in accordance with:
1. NFPA 80 for fire rated doors.
2. NFPA 105 for smoke control doors.
3. ANSI A250.8.
4. Locally adopted Building Code.
5. SDI 117.

Door To Frame Clearances Table

Location		Clearance
Door to Frame at top and sides		1/8 IN 3 MM
Meeting Stiles at Pair Doors		1/8 IN 3 MM
Face of door to face of Stop		3/32 IN 2.4 MM
Door Bottom to Floor / Flooring	Top of floor covering	Less than 1/2 IN 13 MM
	Non-combustible sills	3/8 IN
	Bare floors; No flooring or sills	Greater than 3/4 IN

B. Hardware Preparation:
   1. Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to Door Hardware Schedule and templates furnished as specified in Section 08 71 00.
   2. Locate hardware indicated, or if not indicated, according to ANSI/SDI A250.8.
   3. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
   4. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
   5. Coordinate locations of conduit and wiring boxes for electrical connections.
   6. Remove mill scale and foreign materials, touch up damaged galvanized or galvannealed surfaces.

C. Hollow Metal Doors:
   1. Exterior:
      2. Provide weep openings in bottom of exterior doors.
      3. Seal joints in top edges of doors against water penetration.
   4. Glazed lites:
      a. Factory cut openings in doors.
      b. Locate bottom of glazed panel 43 IN maximum above finish floor.
   5. Astragals:
      a. Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire performance rating or where indicated.

D. Fire Labels:
   1. Affix permanent labels to fire rated units in accordance with testing agency requirements.
   2. Where labels are stamped or embossed directly into frame, ensure label will remain legible upon application of finishes.
   3. At openings where continuous hinges or other items conceal fire label, locate labels on alternative locations as allowed by listing agency and local authorities.

E. Door Position Switches (DPS):
   1. Coordinate locations with Security System provider.
   2. Locate DPS frame head approximately 4 IN from latching door edge.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine structure, substrates, and conditions under which work is to be installed for conditions detrimental to correct and timely completion.

B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Frames:
   1. Place frames before construction of adjacent walls.
      a. Where adjacent walls are cast in place concrete, set frames after wall is constructed.
   2. Adjust hollow metal door frames for square, alignment, twist, and plumb to following tolerances:
      a. Plumb: Plus or minus 1/16 IN , measured at jambs at floor.
      b. Level: Plus or minus 1/16 IN per leaf, measured across width of header.
      c. Square: Plus or minus 1/16 IN , measured at door rabbet on a line 90 DEG from jamb perpendicular to frame head.
      d. Alignment: Plus or minus 1/16 IN , measured at jambs on horizontal line parallel to plane of wall.

e. Twist: Plus or minus 1/16 IN , measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

3. Do not remove spreaders until surrounding wall construction is complete.
4. After surrounding walls have been constructed, verify frames remain in alignment.
   a. Re-check for level, plumb, square, twist and issues that will prevent proper fitting of doors.
   b. Correct deficiencies before allowing surrounding construction to proceed.
   c. Coordinate with other trades to correct alignment problems.
5. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
6. Verify frame alignment, and correct deficiencies prior to hanging doors.
7. Install frames with removable glazing stops located on secure side of opening.
8. Provide anchor type specified for wall condition.
9. Align anchors at hinge centers on hinge jamb and at corresponding heights on strike jamb.
10. Secure frame to wall per manufacturer's instructions.

B. Prime Coat Touchup:
   1. Immediately after erection, sand smooth rusted or damaged areas of primer coat.
   2. Touch up primer coat with compatible air drying primer.
   3. Leave surfaces smooth for finish painting.

C. Field Painting of HM Frames and Doors:
   1. Painting of Exterior openings: Specified in Section 09 91 13.
   2. Painting of Interior openings: Specified in Section 09 91 23.

D. Install Sealants:
   1. Seal frames to walls.
   2. Seal frames to floor slabs and hard floor finishes.
   3. Hairline gap at intersections of head and jamb frames intersections of rabbets and stops:
      a. Fill exposed seam with painter's caulk.
   4. Sealants:
      a. Exterior: See Section 07 92 13.
      b. Interior: See Section 07 92 16.

E. Install silencers.

3.3 ADJUSTING AND CLEANING

A. Verify frames remain in proper alignment.

B. Correct deficiencies before proceeding with surrounding construction.

C. Remove protective wrappings from doors and frames.

D. Verify fire labels are intact, and readily visible.

END OF SECTION

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Flush Wood Doors, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Source Limitations:
   1. Obtain flush wood doors through one source from a single manufacturer.

B. Window and Door Manufacturer's Association (WDMA):
   1. I.S. 1A Industry Standard for Architectural Wood Flush Doors

C. American National Standards Institute (ANSI):
   1. ANSI A115. W Series, Wood Door Hardware Standards.

D. Fire Rated Door Standards:
   1. Label and list for ratings indicated by ITS – Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
   2. Factory apply physical label or approved marking to fire door or fire door frame.
   3. Positive pressure:
      a. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.
         1) The use of surface applied intumescent tape is not acceptable.
      b. Comply with ASTM E2074.

E. Smoke and Draft Control Assemblies:
   1. Maximum air leakage rate of door assembly:
      a. 3.0 CUFTM/SF of door opening at a 0.10 IN of water in accordance with UL 1784.
   2. Applications:
      a. Doors in smoke barriers with fire ratings and fire rated corridor walls.
      b. Doors forming part of an elevator lobby or doors placed at elevator hoistway openings.
   3. Provide S-Labels on smoke and draft control openings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Indicate location, size, and hand of each door; elevation of each kind of door; location and extent of hardware blocking.
   2. Indicate dimensions and locations of cutouts.
   3. Indicate requirements for veneer matching.
   4. Describe factory finish and finish requirements.
   5. Indicate fire ratings for fire doors.

B. Product Data:
   1. Include details of construction for each type of door.
   2. Include factory finishing specifications.
   3. Provide manufacturer's technical data for each type of door including details of core and edge construction, trim for openings and factory finishing specifications.

C. Samples:
   1. Factory finishes applied to actual door face materials for each material and finish.
      a. Provide one piece of specified finished work for each wood species and finish.

b. Minimum Size: 8 x 10 IN indicating finish.

D. Contract Closeout Information:
1. Warranty.

1.4 WARRANTY

A. Provide written warranty for doors for full life of installation against defects including:
1. De-lamination, warp, twist, bow, telegraphing, and other defects that may impair or affect performance of door for purpose intended, meeting allowable values prescribed by WDMA Standard.
2. Remove and replace defective doors; include cost of removal of defective units, re-hanging and refinishing of replacement units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Flush Wood Doors:
1. Base:
a. Marshfield Door Systems.
2. Optional:
a. Eggers Industries.
b. Graham Wood Doors.
c. Mohawk Flush Doors, Inc.
d. Oshkosh.
e. VT Industries.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Wood Door Manufacturers Association (WDMA):
1. Performance: WDMA I.S.1A-11- Extra Heavy Duty.
a. Meet specified performance level without use of additional hardware blocking and without use of through bolts.
2. Aesthetic Grade: WDMA I.S.1A-11, - Premium Grade except as modified.

B. Thickness:
1. 1-3/4 IN unless noted otherwise.

2.3 MATERIALS

A. Veneer:
1. Veneer thickness: 1/50 IN at 12 PCT moisture content.
2. Veneer grade: HPVA Grade A.
3. Veneer Species (both faces unless otherwise noted):
a. Select White Maple.
4. Veneer cut:
a. Plain Sliced.
5. Veneer leaf match:
a. Book match
6. Face assembly match:
a. Running
7. Pair and Set match:
a. Running match
8. Door vertical edges: Veneer edge banding, same species as face, no joints.

B. Core:
1. Select core types which comply with label for scheduled ratings, sizes and hardware devices.
2. Bond cores to stiles and rails; drop-in, unbonded cores are not acceptable.
3. Non-Fire Rated Doors:
   a. PC-5, Extra Heavy Duty Wood Particleboard Core.
   b. Fire-rated doors - 20 MIN:
      1) Core type indicated above for non-rated doors.
   c. Fire-rated doors - 45, 60 and 90 MIN:
      1) Manufacturer's standard Fire Resistant Mineral Core construction as required by label and hardware schedule.
      2) Provide manufacturers standard edge to meet required fire rating.
      3) Include blocking as needed for surface applied hardware.
4. Stiles:
   a. Provide manufacturers standard edge to meet required fire rating.
   b. Fire rated doors: Fabricate stiles from fire retardant material as allowed by label.
   c. Meeting stiles where concealed vertical rod (CVR) exit devices are scheduled.
      1) Avoid use of applied metal channels where label allows fire retardant material as an alternative.

C. Rails:
1. Solid hardwood or structural composite lumber (SCL).

D. Cross-banding:
1. Engineered wood or wood-based composite, securely bonded to core.
2. Medium density fiberboard (MDF) not acceptable.

E. Adhesives:
1. Face adhesive per WDMA TM-6.
2. Utilize waterproof adhesives for doors indicated near potentially wet conditions.

F. Miscellaneous Items:
1. Metal stile channels:
   a. Nominal 5 IN metal edge channels at fire rated pairs equipped scheduled to receive concealed vertical rod (CVR) exit devices.
   b. Use only where fire retardant wood stiles alone are insufficient to satisfy label.
   c. Material and Finish: Stainless Steel. No. 4 Satin Brushed.
   d. Concealed intumescent seals: Include where required by fire label.
   e. Include overlapping metal astragal lip where opening is part of a smoke barrier.
2. Overlapping astragals:
   a. Provide approved overlapping astragals where required by label but not provided in Section 08 71 00, Door Hardware.

2.4 FABRICATION

A. Factory fit doors to suit frame openings with most stringent criteria for uniform clearances in accordance with:
1. National Fire Protection Association NFPA 80 for fire rated doors.
2. National Fire Protection Association NFPA 105 for smoke control doors.
3. American National Standards Institute ANSI A250.8.
4. Locally adopted Building Code.
5. Wood Door Manufacturers Association (WDMA) pre-fit clearances for factory fit doors.

Door To Frame Clearances	
Location	Clearance
Door to Frame at top and sides	1/8 IN

Door To Frame Clearances		
Location		Clearance
Meeting Stiles at Pair Doors		1/8 IN
Face of door to face of Stop		1/8 IN
Door Bottom to Floor / Flooring	Typical; all floor covering types	Up to 1/2 IN
	At non-combustible sills	3/8 IN
	Bare floors- No flooring or sills	Up to 3/4 IN

B. Factory machine doors for hardware that is not surface applied.
   1. Comply with final hardware schedules, shop drawings, and hardware templates.
   2. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   3. Factory pre-drill pilot holes for surface applied items.

C. Hardware Preparation:
   1. Make cutouts accurately and neatly.
   2. Glazed lites:
      a. Factory cut openings in doors.
      b. Locate bottom of glazed panel 43 IN maximum above finish floor.
      c. Do not exceed area allowed by code for rated assemblies.
   3. Provide two sets of glazing stop moldings for openings to completely cover cut edges.
      a. Neatly miter stops at corners.
   4. Cut and trim openings through doors to comply with applicable requirements of referenced standard for kinds of doors required.
   5. Finish as appropriate for material and type:
      a. Veneer wrapped stops: Finish to match face veneer on doors.
      b. Solid wood stops: Finish to match face veneer on doors.
      c. Metal stops: Paint in color to be selected by Architect.
   6. Fill nail holes in wood stops.

D. Top and Bottom Edges:
   1. Render top and bottom edges smooth, non-absorptive and readily cleanable.
   2. SCL rail finish: Make smooth with the application of veneer tape, plastic laminate or clear sealer to finish rough or porous edges.

E. Fire Labels:
   1. Affix permanent labels to fire rated units in accordance with agency requirements.
   2. On openings where continuous hinges or other items would conceal label, place label in alternate location allowed by listing agency and authorities having jurisdiction.

F. Finishes:
   1. Comply with WDMA finish requirements.
   2. Completely finish doors at factory.
   3. Stain (STN):
      a. Type: Manufacturer's standard type.
      b. Stain color:
         1) Match door stain color of existing facility.
         2) System WDMA TR-6 catalyzed polyurethane.
         3) Sheen: 30 to 40.

G. Vertical Door Edges:
   1. Lock stile edges: Beveled 1/8 IN per 2 IN.
      a. Fabricate inactive leaves with a square edge at lock stile edge.
         1) Active leaves to be beveled per above.
   2. Hinge stiles edge: Beveled 1/8 IN per 2 IN.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify suitability of openings to accept installation.

B. Verify frames comply with indicated requirements for type, size, location and swing characteristics and have been installed with level heads and plumb jambs.

C. Reject doors with defects prior to hanging.

D. Normalize wood doors to ambient conditions and to temperature and humidity levels recommended by manufacturer.

E. Do not hang doors in frames set out of plumb, out of square, or out of parallel.

F. Work with frame installer and wall installer to correct misalignment issues.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

H. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Comply with door manufacturer's written instructions, referenced quality standard, and as indicated.

B. Drill pilot holes for screws attaching hinges, closers, lock hardware and other devices to stile or face of door.
   1. Diameter of pilot hole shall not exceed 90 PCT of the root diameter of the screw.

C. Fit doors to frames and machine for hardware, to extent not previously worked at factory.

D. Hardware: For installation, see Section 08 71 00, Door Hardware.

3.3 ADJUSTING

A. Adjust and check doors for proper fit function and uniform clearance at each edge to swing and operate freely.

B. Leave work complete and in proper operating condition.

C. Ensure fire labels are intact, and readily visible.

END OF SECTION

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SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Door Hardware, as indicated, in accordance with provisions of Contract Documents.

B. Notify Architect of items which will not operate properly, attain the required fire label, or where components are physically or functionally incompatible.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Hardware Supplier Qualifications:
   1. Recognized architectural door hardware supplier, with warehousing facilities, who has been furnishing hardware in the project's vicinity for a period of not less than 2 years.
   2. On-staff, experienced Architectural Hardware Consultant (AHC) who is available, during the course of the Work, for consultation about project's hardware requirements.

B. Installer Qualifications:
   1. Supervised or inspected by certified Architectural Hardware Consultant (AHC).

C. Electrified Hardware Supplier Qualifications:
   1. Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design and extent to that indicated for this project and acceptable to manufacturer of materials.
   2. Prepare data for electrified door hardware based on testing and engineering analysis of manufacturer's assemblies similar to those in this project.

D. Fire-Rated Door Assemblies:
   1. Provide door hardware rated for use in assemblies complying with NFPA 80.
   2. Include listed and labeled hardware from a qualified testing agency, for fire-protection ratings indicated,
   3. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.

E. Smoke and Draft Control Assemblies:
   1. Maximum Leakage: 3 CFM per SF of door face area when tested at pressure of 0.10 IN water per UL 1784.
   2. Applicability:
      a. Doors in Smoke Partitions, Smoke Barriers and Corridor walls.
      b. Doors forming part of an Elevator Lobby enclosure.
   3. Provide S-Labels where required.

F. Finish designations and standards: Builders Hardware Manufacturers Association (BHMA) Standard 1301.

G. Regulatory Requirements:
   1. Barrier free design requirements of the local jurisdiction and Americans with Disabilities Act (ADA) and applicable sections of CBC 2013 11B.
      a. Doors and doorways that are part of an accessible route shall comply with CBC Sections 11B-404.
      b. The clear opening width for a door shall be 32" minimum. For a swinging door it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34" and 4" maximum projections into it

between 34" and 80" above the finish floor or ground". Door closers and stops shall be permitted to be 78" minimum above the finish floor or ground. CBC Section 11B-404.2.3

c. Handles, pulls, latches, locks, and other operable parts on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34" minimum and 44" maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable form both side. CBC Section 11B-404.2.7
d. The force for pushing or pulling open a door shall be as follows: CBC Section 11B-404.2.9.
e. Interior hinged doors, sliding or folding doors, and exterior hinged doors: 5 pounds (22.2 N) maximum.
f. Required fire doors: the minimum opening force allowable by the DSA authority, not to exceed 15 pounds (67N).
g. These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.
h. The force required to activate any operable parts shall be 5 pounds (22.2N) maximum to comply with CBC Section 11B-309.4.
i. Door closing speed shall be as follows: CBC Section 11B-404.2.8
j. Closer shall be adjusted so that the minimum required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds.
k. Spring hinges shall be adjusted so that the minimum required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds.
l. Thresholds shall comply with CBC Section 11B-404.2.5.

2. Listing requirements of the local jurisdiction and UL listing where applicable by type.

H. Pre-installation Conference:
1. Prior to installation of hardware, Construction Manager/Contractor conduct an on-site meeting to instruct hardware installer personnel in the proper installation of hardware and related electronics.
a. Manufacturer's Reps for Locksets, Closers, Exit Devices and other major hardware devices shall be present and direct instruction of installers.
b. Require attendance of affected parties, not limited to: Construction Manager/Contractor, hardware installer, electrical installer, door and frame installers and security installer, where applicable, and installer working with low voltage wiring of electromechanical hardware.
c. Discuss installation sequence of components, point-to-point wiring diagrams, and address questions raised by installers.

1.3 SUBMITTALS

A. Shop Drawings:
1. Hardware Schedule:
a. List of products including model numbers and cut sheets for each door.
b. Use Heading Numbers derived from Architect's Hardware Set numbers.
c. Follow guidelines established in Door and Hardware Institute Handbook (DHI) Sequence and Format for Hardware Sets.
2. Diagrammatic Elevations and Point-to-Point Wiring Diagrams of openings scheduled to receive electrified hardware and electronic access control devices.
a. Provide detailed wiring diagrams showing connections for signaling, control and locking functions and notes pertinent to programming, operation, etc.
b. Submit with Hardware Schedule.

B. Project Information:
1. Certification that items bear UL label where required.
2. Meeting minutes from Pre-Installation Meeting.

C. Contract Closeout Information:
   1. Schedule of components installed as hardware sets for each opening.
   2. Operation and Maintenance Data.
      a. Parts catalog for each product furnished.
      b. Keying records.
   3. Owner instruction report.
   4. Letter stating extra material has been delivered.

1.4 JOB CONDITIONS

A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical as the same operation and quality as type specified, subject to Architect's approval.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period, below.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking or breakage.
      b. Faulty operation of operators and door hardware.
      c. Deterioration of metals, metal finishes, and others beyond normal weathering and use.
   2. Warranty Period: Three years from date of Substantial Completion, except as follows:
      a. Electrified exit devices: 12 months from the date of placing the product in operation.
      b. Manual Closers: 10 years from date of placing the product in operation.

1.6 MAINTENANCE

A. Extra Materials:
   1. Provide special tools as supplied by hardware manufacturer, for each different or special hardware component.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Locks, Latches, and Deadbolts:
   1. Base:
      a. Schlage Lock. Campus Standard no substitutions permitted.

B. Cylinders:
   1. Base:
      a. Same manufacturer as listed for Locks, Latches and Deadbolts.

C. Door Closers:
   1. Base:
      a. LCN Closers. Campus Standard no substitutions permitted.

D. Hinges:
   1. Base:
      a. Hager Hinge
   2. Optional:
      a. Stanley Hardware
      b. McKinney
      c. Ives.
      d. Or Equal.

E. Electric Strikes:
   1. Base:
      a. HES
   2. Optional:
      a. Von Duprin.
      b. Or Equal.

F. Door Stops:
   1. Base:
      a. Ives.
   2. Optional:
      a. Sargent Manufacturing.
      b. Corbin Russwin Architectural Hardware.
      c. Hager Hinge.
      d. Trimco.
      e. Or Equal.

G. Overhead Stops and Door Holders:
   1. Base:
      a. Glynn-Johnson. Campus Standard no substitutions permitted.

H. Kickplates, Armorplates, and Door Edging:
   1. Base:
      a. Trimco.
   2. Optional:
      a. Hager Hinge.
      b. Burns Manufacturing.
      c. Ives.
      d. Rockwood Manufacturing.
      e. ABH Manufacturing.
      f. Or Equal.

I. Flushbolts and Coordinators:
   1. Base:
      a. Ives. Campus Standard no substitutions permitted.

J. Thresholds, Head Drips, Weatherstripping, and Smoke Gaskets:
   1. Base:
      a. Pemko.
   2. Optional:
      a. National Guard Products.
      b. Reese.
      c. Zero International.
      d. Or Equal.

K. Key Cabinet:
   1. Base:
      a. Lund Equipment.
   2. Optional:
      a. Telkee.
      b. Or Equal.

L. Door Position Switches (DPS) by Security System:
   1. Provided by Security System Installer.

M. Other materials:
   1. Base: As indicated.

N. Other manufacturers desiring approval comply with Section 01630 and submit samples of both specified item and proposed item for comparison.

2.2 MATERIALS

A. General:
1. Provide hardware for fire rated openings in compliance with UL, NFPA 80 and ADA guidelines.
   a. This requirement takes precedence over other requirements for such hardware.
   b. Provide only hardware which has been tested and listed by UL for types and sizes of doors.
2. Furnish items of hardware for proper door swing.
3. Tactile Warning:
   a. Etched, milled or knurled surface treatment.
   b. Provide on corridor-side levers of doors to loading platforms, boiler and mechanical rooms, stages, utility stairs, roof access, communications and electrical closets.
4. On doors indicated with (LL) hardware, provide either lead lining or lead wrapping of case and thru-bolts as applicable to type of hardware to assure shielding integrity.
5. Notify Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.

B. Templates:
1. Provide templates to door and frame suppliers.
2. List template numbers on Hardware Schedule submittal for use by fabricators.
3. Provide copies of approved Hardware Schedule to related suppliers, fabricators, and installers.
4. Advise Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.

C. Finishes:

Hardware Finishes				
Hardware Component	Satin Chrome Series			
	Base Metal	**ANSI / BHMA**	**Finish Description**	**US Equiv**
Locksets and Latchsets	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Door Pulls, Pushbars, and Pushplates	Stainless Steel	630	Satin Stainless Steel	US32D
Kickplates and Armorplates	Stainless Steel	630	Satin Stainless Steel	US32D
Exit Devices	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Hinges	Stainless Steel	630	Satin Stainless Steel	US32D
	Steel	652	Satin Chromium plated over nickel	US26D
Thresholds, Weatherstripping, Head Drips	Aluminum	719	Mill finish aluminum	US27
Door stops, holders, pivots, door edging and other unlisted items	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Patient Latches	Stainless Steel	630	Satin Stainless Steel	US32D
Exposed arms and covers of closers:	Any	689	Powder Coated Aluminum Color	US20A

D. Fasteners:
1. Manufacture hardware to conform to templates.
2. Prepare for Phillips oval head machine screw installation unless directed otherwise.
3. Provide concealed fasteners (unless through bolted).
4. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.

5. Fasteners in mineral core doors:
   a. Attachment of hinges:
      1) Use fully threaded screws (from tip to head).
   b. Attachment of Closers:
      1) Use through bolts.
      2) Use fully threaded screws at doors with solid wood blocking.
6. Provide non-corrosive fasteners.

2.3 CYLINDERS AND KEYWAYS

A. Cylinders:
1. Comply with BHMA A156.5 Grade 1.
2. Material: Brass or bronze, stainless steel, or nickel silver.
3. Finish: Match lock mechanism to which cylinders are installed.
4. Cylinder Type: Interchangeable cores “)” bitted.
5. IC Format: Full-sized Interchangeable Cores.
6. Determine key type required to suit locking mechanism. Include appropriate trim rings, cams, tail pieces, and adaptors.
7. Patented cylinders and keys to protect against unauthorized manufacture.
8. Provide cylinders for all locking mechanisms scheduled and ship them directly to the facility..
9. Base Product:
   a. Primus Level 4. by Schlage..

B. Keys:
1. Material: Nickel-silver.
2. Stamping: Permanently inscribe each key with a control number and the following: DO NOT DUPLICATE.
3. Quantity: In addition to one extra blank key for each lock, provide the following:
   a. Cylinder Change Keys: 2 blank.

2.4 LOCKS AND LATCHES

A. Cylindrical Locks and Latches:
1. ANSI/BHMA-A156.2, Series 4000, Grade-1.
2. Heavy duty cylindrical with latch bolt throw as follows:
   a. Single doors: 1/2 IN minimum, or as otherwise required by fire label.
   b. Pair doors: 3/4 IN minimum, or as otherwise required by fire label.
3. Backset: 2-3/4 IN.
4. Base Product: ND Series by Schlage.
5. Lever Design: Rhodes lever.
6. Functions as indicated in Hardware Sets and accordance with ANSI/BHMA-A156.2

B. Exit Devices:
1. Base:
2. Von Duprin.

2.5 STRIKES

A. Strikes:
1. Provide manufacturer's standard strike for each latching/locking mechanism.
   a. Finish: Match latch/lock device.
2. Standards: Comply with the following:
   a. Strikes for Bored Locks and Latches: BHMA A156.2.
   b. Strikes for Mortise Locks and Latches: BHMA A156.13.
   c. Strikes for Auxiliary Deadlocks: BHMA A156.5.
3. Strike Lip:
   a. Curved lip extended to protect frame.

b. Locks with 3-piece antifriction latch bolts: Flat-Lip Strikes, where so recommended by manufacturer.
c. Locks used on frames with applied wood casing trim: Extra-Long-Lip Strikes.

B. Strike Boxes:
1. Provide manufacturer's standard Wrought Strike Box for each latching/locking mechanism.
2. Provide specially fabricated Strike Boxes where set in aluminum framing.

2.6 DOOR CLOSERS (SURFACE-APPLIED)

A. Door Closers (surface-applied):
1. Comply with BHMA A156.4, Grade 1.
2. UL-listed for use on fire doors.
3. Body Material: Cast-iron.
4. Base Products:
a. Models 4011 and 4111 by LCN.
b. Models 4041 and 4041XP by LCN.
5. Size door closers to comply with manufacturer's recommendations for door sizes, locations, and accessibility requirements for opening force.
6. Closers adjustable to 3 second closing speed from 70 DEG opening to 3 IN from latch.
7. Supply arms, brackets, and plates, as required.
8. Mount closers on room side of corridor doors, unless conditions prohibit such mounting.
a. Where proposing to locate closers on Corridor side: Notify Architect, in writing, and obtain approval prior to installing.
9. Closers with integral back checks.
10. Entrance and vestibule doors: Delayed action closer and overhead stop.
11. Other exterior out-swinging doors: Closer with limiting cushion stop.

2.7 HINGES

A. Butt Hinges:
1. Standards: Butts and Hinges: BHMA A156.1; Template Hinge Dimensions: BHMA A156.7; Self-Closing Hinges: BHMA A156.17.
2. Full mortise, unless noted otherwise.
a. Non-rising, flat button tips.
b. Non-removable pins (NRP): Provide at out-swinging exterior doors and where specifically indicated.
3. Following table refers to manufacturer's numbers that are considered equal:

Definition of Hinge Types						
Type	Manufacturer				Description	
	Hager	Stanley	Ives	McKinney	ANSI	Remarks
1	BB1199	FBB199	5BB1HW	T4B3386	A5111	Stainless Steel, Heavy Weight, 5-knuckle, 4 Ball Bearing, Non-ferrous for wet/exterior usage.
2	BB1168	FBB168	5BB1HW	T4B3786	A8111	Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel w/ Steel Pin.
3	BB1279	FBB179	5BB1	TB2714	A8112	Standard Weight, 5-knuckle, 2 Ball Bearing, Steel w/ Steel Pin
4	BB1263	FBB268/78	5BB1SCHW	T4B3795	A8121	Swing Clear Hinge, Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel w/ Steel Pin
5	1250	2060R	3SP1	1552	K81071F	Spring Hinge, (single-acting), Steel, Use two Type 5 (Spring Hinges) in combination with Type 2 (Heavy Weight Ball Bearing) hinges
6	--	--	--	1001	K81071F	Double-acting Spring Hinge, Steel, Full mortise, heavy duty

4. Hinges Types according to door location and width:
   a. Type 1 - Stainless Steel, Heavy Weight, Ball Bearing Hinge:
      1) Exterior out-swinging doors with non-removable pins (NRP) option.
      2) Exterior in-swinging doors.
      3) Interior in-swinging doors to wet areas (showers, kitchens, etc.).
   b. Type-2 - Steel, Heavy Weight, Ball Bearing Hinge:
      1) Interior greater than 36 IN wide.
   c. Type-3 - Steel, Normal Weight, Ball Bearing Hinge:
      1) Interior less than or equal to 36 IN.
   d. Type-4 - Swing Clear, Steel, Heavy Weight, Ball Bearing:
      1) Use on openings where specifically indicated or scheduled.
      2) Upgrade to Stainless Steel for exterior and interior wet areas.
   e. Type 5 - Spring Hinges, Steel, Heavy Weight.
      1) Where specifically indicated or scheduled.
      2) Upgrade to Stainless Steel for exterior and interior wet areas.
      3) Use on steel gates in stairs.
5. Hinge quantities per door leaf:

Nominal Leaf Height	Minimum Number of Hinges Required each Leaf
Up to 60 IN	2 hinges
Between 61 IN and 90 IN	3 hinges
Between 91 IN and 120 IN	4 hinges
Between 121 IN and 150 IN	5 hinges
Taller than 151 IN	Add 1 hinge for each 30 IN increase in leaf height thereafter

   a. Specialty Door configurations:
      1) Dutch doors: Refer to Table above for EACH individual leaf.
      2) Nurse-server doors: Refer to Table above for EACH individual leaf.
6. Hinge sizes:

Guide to Minimum Sizes of Hinges			
Door Thickness	Door Width	Minimum Hinge Height	Minimum Hinge Width
1-3/8 IN	Up to 32 IN	3-1/2 IN	3-1/2 IN
	From 32 IN to 36 IN	4 IN	
	Greater than 37 IN	4-1/2 IN	
1-3/4 IN	Up to 36 IN	4-1/2 IN	4-1/2 IN
	From 37 IN to 48 IN	5 IN	
	Over 48 IN	6 IN	
2 to 2-1/2 IN	Up to 42 IN	5 IN Heavy Weight	5 IN
	Over 43 IN	6 IN Heavy Weight	

2.8 ELECTRIC STRIKES

A. General:
   1. BHMA A156.31 Grade 1.
   2. UL-listed for continuous duty.
   3. Field selectable voltage (12/24 VDC).

4. Field selectable operation; Fail Safe (FS)/Fail Secure (FSE).
5. Latch bolt Monitor Switch where indicated.

B. Coordinate model w/lock type and door/frame configurations.

C. Base Product:
1. 7000 Series by HES.

D. Optional Products:
1. 6200 Series by Von Duprin

2.9 POWER TRANSFER

A. Concealed: Mortised into edge of door and frame.
1. UL listed.
2. Determine number of conductors as required by application.

B. Finish: Match finishes indicated for hinges.

C. Base Products:
1. EPT-2 and EPT-10 by Von Duprin.

D. Optional Products:
1. CEPT-2/CEPT-10; PT200/PT1000 by ABH.
2. PTM-2/PTM-10 by Security Door Controls.

2.10 CONTROLLED ACCESS ACCESSORY ITEMS

A. Card Readers (OF/CI):
1. Furnished by Owner/Installed by Contractor.

B. Door Position Switches (DPS):
1. DPS are typically provided by Security System.
   a. Exception: Where Hardware Sets specifically call for DPS to be provided by Section 08 71 00 (this section), refer to the following paragraph.
2. Div 08 Door Position Switches (DPS) specified herein:
   a. Description: Magnetic, concealed mounting, normally closed contacts.
   b. Provided and installed by Hardware supplier/installer.
   c. Base Product: 1078/1076 by GE Interlogix/Sentrol.
      1) Optional Products: 679-05WD/HM by Schlage; 3287 by Sargent; DPS-W/M by Securitron.

C. Request-to-Exit (REX) motion sensors by Security System:
1. REX devices provided with Security System where necessary to shunt alarm.
2. Provided/Installed by Security System Installer.

D. Low Voltage Power (centrally supplied by Security System):
1. Unless otherwise noted, Owner's Security System will provide low voltage power required to power items with current draw less than 2 AMP (24 VDC) including the following:
   a. MagLocks.
   b. Electric Strikes.
   c. Electro-Mechanical Mortise Locksets.
   d. Electro-Mechanical Cylindrical Locksets.

E. Power Supplies (PS) – Division 08 devices installed local to opening:
1. Provide filtered, regulated power.
2. Include relay modules that interface with Fire Alarm System.
3. Select power supply units that are:
   a. Same brand as primary devices being powered.
   b. Capable of receiving Fire Alarm Inputs.
   c. Capable of interfacing scheduled hardware with automatic operators.
   d. Include time delay modules where required for described function.

4. Electrified Exit Devices:
   a. Base Product: PS902 by Von Duprin.
   b. UL-listed.
   c. Include options that interface with Fire Alarm and Automatic Operators.

2.11 OPERATING TRIM AND PROTECTIVES

A. Kickplates and Armorplates:
   1. ANSI/BHMA-A156.6, Type J100.
   2. Material: Stainless Steel; 0.050 IN thick.
   3. Heights:
      a. Kickplates: 10 IN high.
      b. Armorplates: 34IN high.
   4. Widths:
      a. Single Doors: 2 IN less door width (LDW).
      b. Pair Doors: 1 IN less door width (LDW).
   5. Bevel 3 edges of plates.
   6. Coordinate installation of plates with locks and other hardware items; Cut-out where necessary.

2.12 FLUSHBOLTS

A. General:
   1. Include Flushbolts of type indicated in hardware sets.
   2. The following models are considered equivalent:

Flushbolts						
MFR	Manual Flushbolts		Constant Latching Flushbolts		Automatic Flushbolts	
	Wood Doors	Metal Doors	Wood Doors	Metal Doors	Wood Doors	Metal Doors
Ives	FB358	FB458	FB61P	FB51P	FB41P	FB31P
Door Controls	790F	780F	945	845	942	842
Rockwood	557	550	1945	2845	1942	2842

B. Manual Flushbolts (MFB):
   1. Include Dustproof Strikes.

C. Dustproof Strikes:
   1. Base: Ives DP2 or equal
   2. Include with Flushbolts.

2.13 DOOR CONTROL DEVICES

A. Door Stops:
   1. Provide Door Stop at each door leaf.
   2. Use type as indicated in Hardware Set; however, where not specifically indicated in Hardware set provide following types:
      a. Wall-mounted Door Stops:
         1) Provide where door swings more than 110 degrees, and encounters a wall.
         2) Exceptions:
            a) Where door has pushbutton lockset, provide overhead type.
            b) Where double-acting door will not accommodate wall stop on each side of door, provide overhead type.
         3) Base Manufacturer: Ives.
            a) Wood Screw, plastic anchor: WS406CCV.
            b) Screw, drywall anchor: WS407CCV.

b. Overhead Door Stops:
   1) Provide where door swings more than 110 degrees without encountering a wall:
      a) Doors up to 45 IN wide: Overhead stop Glynn-Johnson 450 Series.
      b) Doors over 45 IN wide: Overhead stop Glynn-Johnson 90 Series.
   2) Where exterior door does not have a closer, or does not swing against a wall: Overhead stop provide Glynn Johnson 90 series.
   3) Where exterior door has a closer and does not swing against a wall provide Glynn-Johnson 100 Series concealed overhead door stop.
   4) At Lead-lined doors provide Glynn-Johnson 90 series overhead door stop.
   5) Where double-acting door has no wall adjacent: Glynn-Johnson 100 Series concealed overhead door stop.

B. Door Coordinators:
   1. Base: Ives, COR Series.
   2. Optional: Door Controls, 600 Series, or equal
   3. Provide where indicated.
   4. Provide where astragals are used.
      a. Exceptions:
         1) Coordinators are not required at double egress pairs.
         2) Coordinators are not required where manual Flushbolts are used.
      b. Provide where Automatic and Constant-latching Flushbolts are used.
   5. If coordinator is provided for door which has stop which lacks enough surface area to allow proper mounting; provide shims, bars, etc., as required.
   6. Provide solid shim or other fascia piece that will result in surface being flush with edge of coordinator.
   7. Provide filler sections as required to finish opening.

2.14 PERIMETER SEALS

A. General:
   1. Where doors/frame is extruded aluminum: Refer to Aluminum Door or Frame specifications of description of Perimeter Gasket products.

B. Thresholds:
   1. ANSI/BHMA-A156.6.
   2. Material: Aluminum.
   3. UL and ADA compliant.
   4. Size for frame depth.
   5. Provide required bolt cutouts.
   6. Base Product:
      a. Saddle Thresholds with Thermal-break: S282, S471or S473 by Reese.
      b. Panic Threshold: S248 w/Pile Insert by Reese.
      c. Bumper Seal Thresholds with Thermal-break: 273x292 FGPK by Pemko.
   7. The above items are meant to describe design intent. Contractor to verify that models indicated are appropriate for sill conditions and finishes.
      a. Choose from above models wherever possible.
      b. Include elevators and other adaptors where required.

C. Fire and Smoke Seals:
   1. Provide approved seals as necessary to achieve the fire/smoke labels indicated.
   2. Performance:
      a. Fire Door Assemblies (other than openings also requiring smoke control):
         1) Maximum Air Leakage: Not to exceed 0.50 CFM/FT of crack length as tested according to ASTM E 283.

b. Smoke- and Draft-Control Door Assemblies:
   1) Where smoke- and draft-control door assemblies are required, provide seals that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   2) Air Leakage Rate: Maximum air leakage of 3 CFM/FT2 at the tested pressure differential of 0.1 IN of water.

3. Perimeter Gaskets:
   a. BHMA A156.22; UL-approved for conditions.
   b. Base Product – Frame perimeter seals at jambs and heads:
      1) 303AS by Pemko.
   c. Base Product - Meeting Stiles:
      1) 355CS by Pemko.
4. Astragal:
   a. Provide where indicated.
      1) Where not indicated:
         a) Provide as necessary to obtain fire label.
         b) Provide on pair doors located on exterior wall.
         c) Provide on pairs of radiation resistant doors.
   b. Fire-rated Openings:
      1) Flat steel:
      2) UL listed for labeled doors.
   c. Exterior Openings:
      1) Aluminum with weatherstripping gaskets.

2.15 SILENCERS

A. General:
   1. Silencers are not listed in Hardware sets but are required as described in this Article.
   2. Provide Silencers at openings except those receiving perimeter gasketing such as weather, fire, fire/smoke, and sound gaskets.

B. Silencers:
   1. Diameter: 1/2 IN.
   2. Projection: 1/8 IN.
   3. Tamper-proof.
   4. Base Product – Steel Frames: SR64 by Ives.

2.16 MISCELLANEOUS HARDWARE ITEMS

2.17 OPERATION - KEYING

A. Establish keying system with Owner:

B. Provide and set up complete visible card indexed system with key tags and control slips.

C. Tag and identify keys and install in key cabinet.

D. Provide 2 keys for each lock mechanism. “O” bitted

E. Key to existing master key system by the University

F. Construction Keying:
   1. Provide cylinders with feature that permits voiding of construction keys without cylinder removal.
      a. Provide 10 construction master keys.
   2. Provide construction keying for exterior doors and primary entrances to construction areas.
      a. Construction Manager/General Contractor shall determine which openings will require construction keying based on sequence of construction activities.
      b. Card Reader (by Security System Installer).
   3. Kickplate.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Coordinate reinforcement or other preparation of doors and frames.

C. Installation constitutes responsibility for performance.

D. Coordinate installation power supply and communication wiring to electrically operated devices.

3.2 INSTALLATION

A. Install in accordance with manufacturer's installation instructions, supervised or inspected by an AHC.

B. Fit hardware before final door finishing.

C. Permanently install hardware after finishing operations are complete.

D. Protect finishes by temporary coverings as required.

E. Mounting Heights:

Mounting Heights of Hardware	
Item	**Height** [1,2] (to Item Centerline)
Mortise Locksets	40-5/16 IN AFF to Centerline of Strike [3]
Cylindrical Locksets	
Patient Latches	
Exit Devices	
Door Pulls	42 IN AFF to Centerline of Pull
Pushplates	45 IN AFF to Centerline of Plate
Auxiliary Deadbolts	48 IN AFF to Centerline of Strike
Butt Hinges (and Pivots)	Top Hinge: Not more than 11-3/4 IN down from frame
	Bottom Hinge: Not more than 13 IN above floor
	Equally spaced between Top and Bottom Hinges. Refer to Part 2 for quantity required.
Other Items	Comply with SDI and DHI Recommendations

Footnotes/Additional Requirements:

1. Mounting Heights shall also comply with ADA and ICC/ANSI 117.1
2. Mounting Heights shall also comply with prevailing Building Code and Fire Codes.
3. Deviation of from listed height will be allowed up to + 1-1/2 IN provided this does not cause a conflict of between the lock and lite cutouts.

F. Install hardware with fasteners concealed where not required by code to be exposed.

G. Coordinate installation of electric access control hardware.
   1. Hardware installer to be responsible for coordination with electrical installer for low voltage installations.

H. Door Position Switches (DPS):
   1. Coordinate door and frame preparations with door and frame suppliers, and Security System installer as appropriate.

2. Locate in frame head approximately 4 IN from latching door edge, unless otherwise instructed.

3.3 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware to ensure proper operation or function.
   1. Lubricate moving parts with lubricant recommended by manufacturer.
   2. Replace units which cannot be adjusted and lubricated to operate smoothly.

B. Conversion of Construction Keying to Permanent (by Contractor):
   1. Convert cylinders from Construction to Permanent configuration at time of Substantial Completion.
   2. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology.

C. Approximately six months after substantial completion, check and readjust to assure proper function of doors and hardware.
   1. Clean and lubricate operational items.
   2. Replace items which have deteriorated or failed.
   3. Prepare a written report of current and predictable problems in operation of hardware.
   4. Report visit and furnish copy of report to Owner with copy to Architect.

D. When hardware is installed more than one month prior to final acceptance or occupancy, during week prior to acceptance or occupancy, make a final check and adjustment of hardware items.
   1. Remove temporary coverings.
   2. Clean and lubricate as necessary to assure proper function and finish.
   3. Adjust door control devices to compensate for operation of heating and ventilating equipment.

E. Instruct Owner's personnel:
   1. Operating and maintenance procedures.
   2. Key control system.
   3. Methodology used to re-key cylinders from Construction to Permanent configuration.

F. Prior to substantial completion instruct Owner's personnel in systems operation.
   1. Standard system operation and maintenance.
   2. Modification of codes.
   3. Acquisition, monitoring and scheduling of ID cards.
   4. Instruction in software applications.

3.4 HARDWARE SETS

Set 01	NOT USED

Set 02	NOT USED

Set 03	NOT USED

Set 04	Doors: 2136A			
3 ea	Hinges	FBB199 4.5 x 4.5	652	ST
1 ea	Latchset	ND10S RHO	626	SC
1 ea	Closer	4011	689	LC
1 ea	Kick Plate	8400 10" x 2" LDW x B4E	630	IV
1 ea	Mop Plate	8400 6" x 1" LDW x B4E	630	IV
1 ea	Wall Stop	WS406CVX	630	IV
3 ea	Silencers	SR64		IV

Set 05	NOT USED

Set 06	NOT USED

Set 07	0102. CR4100C			
3 ea	Hinges	FBB168 4.5 x 4.5	652	ST
1 ea	Storeroom Lockset	ND60JD RHO	626	VO
1 ea	Permanent Core	20-740XP	626	SC
1 ea	Closer	4011 (4111-EDA @ outswing)	689	LC
1 ea	Kick Plate	8400 10" x 2" LDW x B4E	630	IV
1 ea	Floor Stop	FS18	630	IV
1 ea	Seal	303AS (head & jambs)		PE

Set 08	Doors: 0101, 1200			
6 ea	Hinges	FBB179 4.5 x 4.5	652	ST
1 set	Auto Flush Bolts	FB31P	626	IV
1 ea	Dust Proof Strike	DP2	626	IV
1 ea	Storeroom Lockset	ND80JD RHO	626	VO
1 ea	Permanent Core	20-740XP	626	SC
1 ea	Coordinator	COR x mounting brackets as required		IV
2 ea	Closer/Stop	4111-CUSH	689	LC
2 ea	Kick Plate	8400 10" x 1" LDW x B4E	630	IV
1 ea	Seal	303AS (head & jambs)		PE
1 ea	Astragal	By door manufacturer		

Set 09	NOT USED

Set 10	Doors: 5000			
3 ea	Hinges	FBB191 4.5 x 4.5	630	ST
1 ea	Exit Device	AX 99L x 996L-06	626	VO
1 ea	Storeroom Lockset	ND60JD RHO	626	VO
1 ea	Permanent Core	20-740XP	626	SC
1 ea	Closer/Stop	4111-CUSH	689	LC
1 ea	Kick Plate	8400 10” x 1” LDW x B4E	630	IV
1 ea	Seal	303AS (head & jambs)		PE
1 ea	Door Sweep	315CN		PE
1 ea	Rain Drip	346C		PE

Set 11	Doors: 5001			
3 ea	Hinges	FBB191 4.5 x 4.5	652	ST
1 ea	Rim Cylinder	20-079	626	SC
1 ea	Permanent Core	20-740XP	626	SC
1 ea	Closer/Stop	4111-CUSH	689	LC
1 ea	Kick Plate	8400 10” x 2” LDW x B4E	630	IV
1 ea	Seal	303AS (head & jambs)		PE
1 ea	Door Sweep	315CN		PE
1 ea	Threshold	Per detail		PE
1 ea	Rain Drip	346C		PE

Set 12	NOT USED

Set 13	NOT USED

Set 14	NOT USED

Set 15	Doors: CR2100A (ALT), CR2100B (ALT), CR3100A (ALT), CR3100B (ALT) CR4000C (ALT), CR4100A (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX99L-NL	626	VO
1 ea	Power Supply	PS902-2RS		VO
1 ea	Door Position Switch	By security vendor		
1 ea	Card Reader	By security vendor		
	Balance of Hardware	Existing to remain		

Set 16	Doors: 1000C (ALT), CR2200 (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX33A NL-OP	613	VO
1 ea	Power Supply	PS902-2RS		VO
1 ea	Door Position Switch	By security vendor		
	Card Reader	By security vendor		
	Balance of Hardware	Existing to remain		

Set 17	Doors: CR1100 (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX33A NL-OP	613	VO
1 ea	Exit Device	AX33A NL-OP	613	VO
1 ea	Power Supply	PS902-4RS		VO
2 ea	Door Position Switch	By security vendor		
1 ea	Card Reader	By security vendor		
2 ea	Auto Op Activator	IS36-5	BZ	WI
	Note:	Provide BPS-INGR if conditions warrant		
	Balance of Hardware	Existing to remain		

Set 18	Doors: CR2100.1 (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX33A NL-OP	613	VO
1 ea	Power Supply	PS902-2RS		VO
2 ea	Door Position Switch	By security vendor		
1 ea	Card Reader	By security vendor		
	Balance of Hardware	Existing to remain		

Set 19	Doors: CR2100.3 (ALT), CR2200A (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX99L-NL	626	VO
1 ea	Power Supply	PS902-2RS		VO
2 ea	Door Position Switch	By security vendor		
1 ea	Card Reader	By security vendor		
	Balance of Hardware	Existing to remain		

Set 20	Doors: CR2200B (ALT), CR3200 (ALT) CR3200A (ALT)			
1 ea	Door Loop	788-12		SC
1 ea	Electrified Exit Device	QEL RX AX9927L-NL (F) LBR	626	VO
1 ea	Exit Device	AX9927EO (F) LBR	626	VO
2 ea	Door Position Switch	By security vendor		
1 ea	Card Reader	By security vendor		
	Balance of Hardware	Existing to remain		

END OF SECTION

SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Member of Certified Steel Stud Association (CSSA), Steel Stud Manufacturers Association (SSMA) or Steel Framing Industry Association (SFIA).

B. ASTM International (ASTM):
   1. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
   2. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   3. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
   4. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold-Formed Framing Members.

C. Provide studs and accessories of type tested and listed for construction indicated.

D. Gypsum Association (GA):
   1. GA-216 Application and Finishing of Gypsum Panel Products.
   2. GA-234 Control Joints for Fire-Resistance Rated Systems.

1.3 SUBMITTALS

A. Product Data:
   1. Provide copies of manufacturer's specifications and installation instructions for each type of material and accessory required.
      a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
      b. Include data required to show specification compliance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Non-Structural Metal Framing:
   1. Base:
      a. Telling Industries
   2. Optional:
      a. CEMCO Steel Framing and Metal Lath
      b. ClarkDietrich Building Systems
      c. Custom Stud Inc.
      d. Marino/WARE
      e. MBA Metal Framing
      f. MRI Steel Framing LLC.
      g. The Steel Network

B. Isolation Strip Material:
   1. Base:
      a. Reflectix, Inc.
   2. Optional:
      a. Saint-Gobain

C. Knee Wall Brace:
   1. Base:
      a. Pittcon Industries

D. Interlocking Grid Support Systems for Gypsum Board Ceilings:
   1. Base:
      a. USG Corporation
   2. Optional:
      a. Armstrong
      b. Chicago Metallic

E. Other manufacturers desiring approval comply with Section 01630.

F. Products proposed for use in fire-rated assemblies:
   1. Approved by nationally recognized testing laboratory.

2.2 DESIGN CRITERIA

A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

Performance Criteria		
Use Condition [2]	Design Pressure	Maximum Deflection
Wall enclosing stairs, elevator hoistways, and other vertical shafts	10 LBS/SF	L/240
Wall enclosing vestibules, ground floor lobbies, and similar spaces subject to intermittent exposure to exterior wind conditions	15 LBS/SF	L/240
Walls scheduled with Tile Backer Board, Moisture-Resistant, Impact-Resistant, or Abuse-Resistant Gypsum Wallboard	5 LBS/SF	L/360
Walls scheduled to receive Tile, lath and plaster, or veneer plaster. [1]		
Typical Interior Walls/Partitions (those not listed above)	5 LBS/SF	L/240
Interior Ceilings, Soffits and Bulkheads	5 LBS/SF	L/360

Footnotes
1. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile, Thin Brick, Lath & Plaster, Simulated Masonry, Adhered-stone, Veneer Plaster and similar brittle finishes which are prone to movement-induced cracking.
2. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

2.3 MATERIALS

A. Metal Studs and Floor Tracks:
   1. C-shaped, roll-formed studs and tracks conforming to ASTM C645.
   2. Galvanized: G40.
   3. Stud and track depths: As indicated by wall type.
   4. Minimum flange width: 1-1/4 IN .
   5. Minimum thickness: 18 MIL (25 GA), except as follows:
      a. Increase member thickness to comply with performance criteria.

b. Increase member thickness to minimum 30 MIL (20 GA) studs at following conditions:
   1) Jambs of openings: Two 30 MIL (20 GA) studs.
   2) One or both sides of walls faced with any of following:
      a) Wall mounted cabinetry and equipment.
      b) Tile backing board.
      c) Adhered stone.
      d) Plaster.
      e) Moisture-resistant.
      f) Abuse-resistant wallboard.
      g) Lead backed gypsum wallboard.
   3) Where walls do not extend to overhead structural deck, and without supporting diagonal bracing, or horizontal stiffeners.

6. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
   a. Coordinate locations with building services items.
   b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
7. High strength 50KSI studs shall comply with design criteria of equivalent thickness standard 33KSI studs listed.
8. Base products:
   a. Drywall Framing System by Telling Industries.
9. Optional products, high strength steel:
   a. Viper Stud by Telling Industries.

B. Head of Wall Accessories:
1. Configure to accommodate deflection of superstructure without inducing axial loading on partition wall.
2. Maintain structural integrity, fire and smoke-resistance, and sound control as required by each wall.
3. Slotted top deflection track:
   a. Deep leg, vertically slotted track.
   b. Cold-formed sheet steel; galvanized; G60.
   c. Thickness: 30 MIL (20 GA) minimum.
   d. Width: As required for studs sizes indicated.
   e. Depth: Minimum 2-1/2 IN down-standing legs with 1/4 IN wide by 1-1/2 IN high slots spaced 1 IN on center.
4. Z-bars, cold formed channels and clips:
   a. Accommodate thickness of spray-applied fire-resistive materials.
5. UL-listed fire resistant components tested for compliance with requirements indicated.
6. Firestopping Materials:
   a. Sealants, sprays, intumescent strips and forming materials.
   b. Coordinate with sealants specified in Section 07 84 00 and Section 07 92 16.
   c. Intumescent applications:
      1) Factory or field applied.

C. Shaftwall Framing:
1. C-T or C-H shaped studs with U or J shaped tracks.
2. Material: Galvanized steel; G40.
3. Thickness: 30 MIL (20 GA) minimum.
4. Size: 2-1/2, 4, and 6 IN minimum as indicated.
5. Structural design criteria:
   a. Select stud with properties necessary to limit deflection to L/240 deflection at load of 10 PSF .
   b. Use larger size and thickness to satisfy span and deflection criteria.

6. Shaftwall assembly with gypsum wallboard specified in Section 09 29 00:
   a. Fire resistance tested in accordance with ASTM E119.
   b. Sound transmission loss: Tested in accordance with ASTM E90.
7. Base product: CT Cavity Shaftwall Studs by Telling Industries.

D. Z-Bar Standoff Clips:
1. 30 MIL (20 GA) galvanized steel.
2. Provide Z-bars for attachment of top track to superstructure elements which are to be protected with sprayed fireproofing.
   a. Size: 2 IN x 2 IN x 2 IN .
3. Length:
   a. As required to accommodate beam and deck fireproofing.
      1) At structural steel member: Length equal to flange width of structural steel member.
      2) At steel deck: Minimum length equal to partition width, or as required to span steel deck flutes.
   b. Extend length of Z-bar to accommodate partition offset that will not clear fireproofed steel beam.
4. Base product: ZFC by Telling Industries.

E. Furring Channels:
1. Hat shaped sections.
2. Galvanized: G40.
3. Sizes: 7/8 IN and 1-1/2 IN, as indicated.
4. Minimum Thickness: 30 MIL (20 GA) ; Use heavier gauge as dictated by conditions.
5. Base product: DWFC by Telling Industries.

F. Z-Furring:
1. Z-shaped sections, attached to structural parent wall.
2. Galvanized: G40.
3. Sizes: 1, 1-1/2, and 2 IN.
4. Thickness: 18 MIL (25 GA) minimum. Use heavier gauge as dictated by conditions.
5. Base product: ZFC by Telling Industries.

G. Accessory Items:
1. Wire Ties:
   a. Minimum thickness: 43 MIL (18 GA) soft annealed, galvanized.
2. Track Fasteners:
   a. Power driven type, to withstand minimum 190 LBS shear when driven.
3. Closure:
   a. Continuous 30 MIL (20 GA) galvanized closure angle to receive vapor retarder and vapor retarder tape.
4. Isolation Strip Material:
   a. Non-absorbent, foam padding to prevent direct contact between metal framing and exterior concrete or masonry.
   b. Thickness: 0.40 MIL minimum.
   c. Install continuous strips in widths to match steel framing and furring.
   d. Base product: Sill Sealer by Reflectix, Inc.
5. Metal Blocking:
   a. C-shaped modified track runners.
   b. G40 galvanized.
   c. Backing height: 6 IN minimum.
   d. Flange width: 1-1/4 IN minimum.
   e. Thickness: 30 MIL (20 GA) minimum.
6. Backing - Flat Plate:
   a. Flat, sheet metal stock per ASTM A1008.
   b. G40 galvanized.

c. Thickness: 50 MIL (18 GA) minimum.

7. Knee Wall Brace:
   a. Steel tube and baseplate bolted to concrete floor slab with tube projecting vertically; concealed within framed walls to provide structural stability for knee walls.
   b. Design components compatible with wall type.
   c. Material: Cold-rolled steel tube and base plate, fully welded.
   d. Overall height: Wall height less 2 IN .
   e. Spacing as recommended by manufacturer.
   f. Base product: SKB by Pittcon Industries.
8. Shower Seat Support:
   a. Conceal in framed walls.
   b. Vertical steel channels with welded steel plate.
   c. Anchor channels to floor and structure above with steel angles.
   d. Provide stainless steel sleeves at each bolt that attach shower seat to support bracket in wall
      1) Extend past finish face of wall tile 1/8 IN .
   e. Components:
      1) C3 x 6 cold formed steel channel.
         a) Brace with horizontal channel at 96 IN AFF.
      2) Steel plate: 24 x 20 x 3/8 IN .
         a) Weld to steel channels with top of plate at 20 IN AFF.
      3) Steel angles: 3 x 3 x 1/4 x 3 IN .
      4) Stainless steel sleeves: 3/8 IN diameter.
      5) Expansion bolts with 3-1/2 IN embedment.

H. Support Systems for Gypsum Ceilings:
1. Interlocking Grid Systems:
   a. ASTM C635, direct-hung system composed of T-Shaped framing members designed to carry load of screw-applied gypsum ceiling board.
   b. Tabs on Cross-Tees to interlock into slots in Main Runners where intersections occur.
   c. Base Product: Drywall Suspension System by USG Corporation.
2. Track and Channel Systems:
   a. ASTM C645 roll-formed steel with G40 galvanized coating.
   b. Thickness: 30 MIL (20 GA) minimum; Use heavier gauge as dictated by conditions.
   c. Carrying channels:
      1) Size: 1-1/2 IN .
   d. Furring channels:
      1) Sizes: 7/8 IN and 1-1/2 IN , as indicated.
3. Stud-Framed Ceiling/Soffit Systems:
   a. C-shaped studs or joists; roll-formed.
   b. Galvanized: G40.
   c. Frame member depth: 3-5/8 IN minimum, unless otherwise indicated.
      1) Use wider stud sections if ceiling span and support requires.
   d. Flange width: 1-1/4 IN minimum.
   e. Stud thickness: 33 MIL minimum.
4. Tie Wire:
   a. ASTM A641, Class 1 zinc coating, soft temper.
   b. Diameter, single-strand: 62 mils (14 GA) minimum.
   c. Diameter, double-strand: 42 mils (18 GA) minimum.
5. Wire Hangers:
   a. ASTM A641, Class 1 zinc coating, soft temper.
   b. Diameter: 97 mils (12 GA) minimum.
6. Anchors in Concrete:
   a. Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times

that imposed by ceiling construction, as determined by testing per ASTM E488 or ASTM E1512 as applicable.

b. Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.

c. Material: Carbon-steel components zinc plated to comply with ASTM-B633, Class Fe/Zn 5 for Class SC 1 service condition.

7. Powder-Actuated Fasteners in Concrete:
   a. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
   b. Comply with seismic design requirements where applicable.
8. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine supporting structure and conditions under which system will be installed.

B. Correct conditions detrimental to proper installation.

C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Layout and install metal framing accurate to dimensions indicated in drawings.

B. Installation Standard: ASTM C754, except comply with framing sizes and spacing indicated.
   1. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 relative to framing installation.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

G. Extend framing full height to structural supports.
   1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.
   2. Continue framing around ducts and similar items which penetrate partitions.

H. Position studs vertically engaging floor track and head of wall deflection track.
   1. Align stud knockouts to facilitate running of wires and conduit.

I. Space studs maximum 16 IN on center.
   1. Stud spacing at Shaftwall: 24 IN on center.

J. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.

K. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool on both flanges of each stud.

L. Anchor studs to deflection track with wafer head screws on both flanges of each stud.
   1. Maintain deflection gap between top of stud and top of slotted track.

2. Install screws at centerline of slot and secure allowing vertical movement.

M. Anchor fire rated partitions as required by fire resistance design, and firestopping design.

N. Where partitions abut vertical structural elements, provide perimeter relief per Gypsum Association GA-600 Strain Relief System details.

O. Head-of-Wall:
1. Provide slotted top track for walls extended to structure.
2. Configure to resist lateral loads while accommodating deflection of overhead building superstructure without inducing axial loading on partition framing.
3. Secure deflection track to structure in accordance with industry standards and regulatory requirements.
4. Secure at corners and at ends.
5. Cut vertical studs 5/8 IN short to create a deflection gap when installed into top track.
   a. Secure vertical studs to top track with framing screw at each stud flange, screwing through track slots for positive stud connection.
6. Secure Gypsum Wallboard to vertical studs; do not secure Gypsum Wallboard to top track directly.
7. Where partitions attach to structural elements that are scheduled to receive Spray-applied Fire Resistive Materials (SFRM):
   a. Install Z-bar to underside of steel beams and steel deck before application of sprayed fireproofing.
   b. Locate Z-bars perpendicular to line of partition, spaced maximum 16 IN on center.
   c. Attach each Z-bar with two 0.145 IN x 1 IN powder-actuated fasteners located minimum 1 IN from ends of Z-bar.
   d. After fireproofing, secure top track to Z-bars with No. 8 x 5/8 IN wafer head framing screws spaced maximum 16 IN on center.
8. Where fire-rated partitions are offset and will not clear fireproofed steel beam, extend Z-bar outrigger horizontally from bottom of beam out to minimum 2 IN beyond width of head-of-wall.
   a. Attach 3/4 IN expanded metal lath continuous, width of top of Z-bar outriggers prior to fireproofing steel beam to accommodate sprayed fireproofing.
9. Prepare wall for installation of seals, firestopping, or both:
   a. Fire-rated Walls: Prepare for fire-resistive joint assemblies specified in Section 07 84 00.
   b. Non-fire rated partitions including Smoke Partitions: Prepare for Acoustical Sealant specified in Section 07 92 16.

P. Furring Channels:
1. Attach furring channel systems directly to parent walls.
2. Install channels at maximum 16 IN OC.
3. Provide additional framing at openings, cutouts, corners, and control joints.
4. Space fasteners not more than 24 IN OC, staggered on opposite flanges of furring channels.

3.3 FRAMING AT OPENINGS

A. Control Joints (CJ):
1. Install additional stud, maximum 1/2 IN from jamb studs.
2. Do not fasten extra stud to track or jamb stud.
3. Refer to specification Section 09 29 00 for control joint locations.

B. Prefabricated headers, jambs, and sill framing systems option:
1. Proprietary opening framing systems may be used as an alternative to conventionally fabricated framing.
2. Pre-approved Products:
   a. HDS Framing System by ClarkDietrich.
   b. Quick Frame Rough Opening System by Marino/ Ware.

C. Door Openings:
   1. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section for cripple studs at head and secure to jamb studs.
   2. Unless indicated otherwise, extend jamb studs through suspended ceilings and secure laterally to overhead structure.
   3. Jamb Studs:
      a. Install two studs at each jamb, unless otherwise indicated.
      b. Minimum thickness of jamb studs: 30 MIL (20 GA)at openings.
      c. Securely attach jamb studs to door frames.
      d. Attach drywall to both studs equally.
   4. Headers:
      a. Openings less than 4 FT wide:
         1) Cut-to-length section of floor runner above and below wall openings.
         2) Split flanges and bend webs at ends.
         3) Overlap and screw attach jamb studs to frames.
      b. Openings over 4 FT wide:
         1) Cut-to-length, horizontal box beam studs above and below wall openings.
         2) Design for actual span and loading.
      c. Incorporate miscellaneous steel members, specified in Section 05 50 10, and wood blocking, specified in Section 06 10 00, where indicated.
   5. Control Joints at head of jambs:
      a. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2 IN clearance from jamb stud to allow for installation of control joint in finished assembly.

D. Other Framed Openings:
   1. Frame openings other than door openings the same as required for door openings, unless otherwise indicated.
   2. Install framing below sills of openings to match framing required above door heads.
   3. Cripple Studs:
      a. Install cut-to-length intermediate vertical studs above and below openings.
      b. Spacing: As indicated for typical full-length studs.
   4. Incorporate miscellaneous steel members, specified in Section 05 50 10, and wood blocking, specified in Section 06 10 00, where indicated.

3.4 WALL BACKING AND BLOCKING

A. Metal Wall Backing: Provide in-wall metal wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:
   1. Crash rails, chair rails, wall bumpers, and similar wall protection devices.
   2. Contractor or Owner-furnished equipment indicated to be wall-mounted.
   3. Toilet accessories that do not include proprietary backing devices.
   4. Toilet partitions and lockers.
   5. Markerboards, tackboards, and chalkboards.
   6. Other wall-mounted items where backing is indicated by details or specification.

B. Coordinate mounting height, location, and coverage with item to be supported.

C. Determine material width according to item to be supported.

D. Provide in-wall metal wall backing material to interior metal stud walls specified herein and Exterior stud walls specified in Section 05 40 00.

E. Attachment: Minimum 2 - #10 sheet metal screws at each stud.

3.5 CEILING FRAMING

A. Install in compliance with manufacturer's recommendations.

B. Provide required items to support and trim out neatly, flush or recessed mechanical and electrical items.

C. Frame openings in ceiling support system to accommodate access panels and similar openings and penetrations.
   1. Completely frame openings with closed channel side of stud facing opening for support of recessed mechanical and electrical items.

3.6 CEILING SUPPORT SYSTEMS

A. Install suspension system components in sizes and spacing indicated on Drawings, but not less than required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where abutting or penetrated by building structure.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and secure fasteners appropriate for substrate.
   4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and secure fasteners appropriate for structure and hanger.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Grid Suspension Systems:
   1. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
   2. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
   3. Install suspension systems that are level to within 1/8 IN in 12 FT measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

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SECTION 09 29 00
GYPSUM WALLBOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Gypsum Wallboard in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM C475 Joint Compound and Joint Tape for Finishing Gypsum Board.
   2. ASTM C840 Application and Finishing of Gypsum Board.
   3. ASTM C841 Installation of Interior Lathing and Furring.
   4. ASTM C954 Steel Drill Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
   5. ASTM C1002 Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
   6. ASTM C1047 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
   7. ASTM C1396 Standard Specification for Gypsum Board.
   8. ASTM C1629 Abuse-Resistant Non-decorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
   9. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
   10. ASTM E84 Surface-Burning Characteristics of Building Materials.
   11. ASTM E90 Sound Transmission Testing.
   12. ASTM E119 Fire Tests of Building Construction.
   13. ASTM E413 Classification for Rating Sound Insulation.
   14. ASTM F2547 Standard Test Method for Determining the Attenuation Properties in a Primary X-ray Beam of Materials Used to Protect Against Radiation Generated During the Use of X-ray Equipment

B. Gypsum Association (GA):
   1. GA-216 Application and Finishing of Gypsum Panel Products.
   2. GA-234 Control Joints for Fire-Resistance Rated Systems.
   3. GA-238 Guidelines for Prevention of Mold Growth on Gypsum Board.

C. Fire Resistant Rated Assemblies:
   1. For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
   2. Provide materials listed by UL, or other approved testing laboratory, for construction and rating type indicated.

D. STC Rated Assemblies:
   1. Provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
   2. Facility Guidelines Institute (FGI):
      a. FGI Guidelines For Design and Construction of Healthcare Facilities:
         1) Sound and Vibration Requirements.
      b. 2010 FGI Guidelines For Design and Construction of Healthcare Facilities.

3. American National Standards Institute (ANSI):
   a. ANSI S1.1 American National Standard Acoustical Terminology.
   b. ANSI S1.4 American National Standard Specification for Sound Level Meters.
   c. ANSI S1.4 American National Standard Specification for Sound Level Meters.
   d. ANSI S1.43 American National Standard Specifications for Integrating-Averaging Sound Level Meters.
4. ASTM International (ASTM):
   a. ASTM C423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   b. ASTM C634 Standard Terminology Relating to Building and Environmental Acoustics.
   c. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   d. ASTM E366 Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
   e. ASTM E413 Classification for Rating Sound Insulation.
   f. ASTM E966 Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Façade Elements.
5. American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. ASHRAE 2007 Handbook: Chapter 47 – Sound and Vibration Control.

E. Radiation Shielding Assemblies:
1. National Council on Radiation Protection and Measurement (NCRP):
   a. NCRP Report No. 147 Structural Shielding and Design Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10MeV
   b. Comply with requirements of local, state or federal regulatory agencies where building or safety standards or criteria exceed NCRP Report Numbers 49 and 147.
2. Fabricator-Installer Qualifications:
   a. Not less than ten (10) years' experience in successful fabrication and installation of radiation protection similar to work specified.
   b. Furnish proof of insurance certifying Fabricator-Installer is specifically fabrication and installation of X-ray Protection Materials for Shielding.
3. Certification:
   a. Furnish certificate of compliance signed by Manufacturer and Fabricator-Installer stating materials are in accordance with Contract Documents and physicist shielding report.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer's specifications for each type of material and accessory.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gypsum Wallboard:
1. Base:
   a. Georgia Pacific (GP).
2. Optional:
   a. American Gypsum.
   b. CertainTeed.
   c. Continental Building Products.
   d. National Gypsum Company (NGC).
   e. Pabco Gypsum.
   f. United States Gypsum (USG).

B. Lead Product Suppliers:
   1. Base:
      a. A&L Shielding.
   2. Optional:
      a. NELCO.
      b. Ameray.
      c. Radiation Protection Products.
      d. Ray Bar Engineering.
      e. Mayco.

C. Acoustically Enhanced Gypsum Wallboard Composite:
   1. Base:
      a. National Gypsum Company.
   2. Optional:
      a. CertainTeed.
      b. Pabco Gypsum.
      c. Supress Products, LLC.

D. Drywall Trim Accessories:
   1. Base:
      a. United States Gypsum (USG)
   2. Optional:
      a. ClarkDietrich.
      b. Phillips Manufacturing.
      c. Structus Building Technologies.

E. Specialty Drywall Trim:
   1. Base:
      a. Pittcon Industries.
   2. Optional:
      a. Fry Reglet Corp.
      b. Gordon, Inc.

F. Foam Tape:
   1. Base:
      a. As noted.

G. Sound Attenuation Batts (SAB):
   1. Base:
      a. As noted.

H. Preformed Acoustical Seal for Wall Boxes:
   1. Base:
      a. STC Architectural Products.

I. Pressure Sensitive Fire Tape:
   1. Base:
      a. E-Z Taping System.

J. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Furnish in maximum available lengths, consistent with installation requirements.
   1. Long Edge: Tapered.
   2. Short Ends: Square.

B. Upgrade listed types to fire rated equivalent products when used in fire rated assemblies.

C. Provide listed GWB products to mold and moisture resistant types, where wallboard is installed in Electrical, Communication Rooms, Mechanical shafts, Stair Shafts and similar locations where wallboard is installed prior to building being weathertight.

D. Exterior Gypsum Sheathing: Specified in Section 06 16 43.

E. Framing and suspension systems for Gypsum Board Ceilings: Specified in Section 09 22 16.

F. Firestopping: Specified in Section 07 84 00.

G. Thermal Insulation: Specified in Division 07 sections.

H. Interior face of exterior walls and rooms where moisture or high humidity is present:
1. Mold and moisture resistant gypsum panels (MRGWB).
2. Gypsum panels, with glass mat facer per ASTM C1658.
3. Thickness: 5/8 IN .
4. Mold resistance score: 10 per ASTM D3273.
5. Apply continuously to interior face of exterior stud walls prior to framing interior partitions and ceilings.
6. Where MR wallboard is scheduled in fire rated walls, provide approved fire resistive products with comparable moisture resistance.
7. Base product:
   a. DensArmor Plus Interior Panel and DensArmor Plus Fireguard Interior Panel Fireguard by Georgia Pacific.

I. Interior Partitions and Ceilings:
1. Gypsum panels - Type X:
   a. ASTM C1396.
   b. Thickness: 5/8 IN .
   c. Type X core.
   d. Base product:
      1) ToughRock Fireguard X Gypsum Wallboard by Georgia Pacific.
2. Tile Backer Board (TBB):
   a. Moisture resistant treated gypsum core, glass mats on both sides, and acrylic water barrier or water resistant gypsum coating on finished side.
   b. Provide TBB at walls of showers, tub rooms, toilet rooms, decontamination rooms, and similar walls where tile is scheduled.
   c. Thickness: 1/2 IN .
   d. Thickness: 5/8 IN type X at rated walls.
   e. Mold resistance score: 10 per ASTM D3273.
   f. Base Products:
      1) Non-Rated Walls: DensShield Tile Backer by Georgia Pacific.
      2) Fire Rated Walls: DensShield Fireguard Tile Backer by Georgia Pacific.
   g. Include Level 5 finish at non-tiled portions.
3. Lead Lined Gypsum Wallboard (LLGWB):
   a. Lead sheet factory laminated to gypsum board carrier.
      1) Panel size: 48 IN wide x manufacturer's standard lengths, with lead edge flanges.
   b. Gypsum wallboard substrate:
      1) ASTM C1396
      2) 5/8 IN thick
      3) Type X.
   c. Lead Sheet:
      1) Unpierced, ASTM B749, alloy UNS L51121, chemical-copper lead.
      2) Lead Thickness: As indicated.
         a) Variation in sheet thickness: Less than 3 PCT.
      3) Extend lead 1 IN beyond edge of gypsum panel.

d. Accessories:
1) Lead battens, tabs, and disks as prescribed by UL Designs indicated, to compensate for loss of integrity at screw penetrations.
a) 0.125 IN to 0.146 IN thick.
b) Lead Battens: 2 IN wide strips.
c) Lead Tabs: 2 IN x 5 IN .
d) Lead Disks: of
2) Lead Angles:
a) Leak proof, lead angle system providing complete coverage of gamma rays.
b) Use at inside corners.
3) Sheet lead to wrap electrical outlets, pipe and duct penetrations, and similar penetrations.
e. Related radiation shielding enclosure items specified elsewhere:
1) Lead-lined steel frames: Specified in Section 08 11 13.
2) Lead-lined wood doors (wood veneer faced): Specified in Section 08 14 16.

J. Trim:
1. Interior Trim:
a. Material: Galvanized or aluminum coated steel sheet, rolled zinc, paper faced galvanized steel sheet, or paper faced structural laminate.
b. Material for wet areas: Zinc.
c. Shapes:
1) Corner bead.
2) LC-Bead: J-shaped; exposed long flange receives joint compound.
3) L-Bead: L-shaped; exposed long flange receives joint compound.
4) U-Bead: J-shaped; exposed short flange does not receive joint compound.
5) Control joint.
6) Curved Edge Corner bead: With notched or flexible flanges.
7) Other items as indicated.
2. Specialty trim:
a. Profiles and dimensions indicated.
b. Material: 6063-T5 Aluminum.
c. Material: _____.
d. Finish: Factory primed for field finishing.
e. Finish: Class II anodic finish.
f. Finish: Factory painted, baked enamel finish.
g. Flanges to be embedded: Corrosion resistant primer compatible with joint compound and finish materials indicated.

K. Joint Treatment Materials:
1. Use product types recommended by wallboard manufacturer for each condition.
2. Materials compatible with other compounds applied previously or on successive coats.
3. Provide dust control products in occupied areas or adjacent to occupied areas.
4. Joint tape:
a. Interior gypsum wallboard: Paper.
b. Tile backing panels: As recommended by panel manufacturer.
5. Joint compounds for interior gypsum wallboard:
a. Setting type joint compound:
1) Filling open joints and voids.
2) Embedding tape and first coat over joints, fasteners and trim flanges.
6. Lightweight setting type joint compound:
a. Second coat.
b. Final, skim coat on surfaces receiving a Level 5 finish.
c. Drying type all purpose joint compound:
1) Second and third coats.
2) Final, skim coat, on surfaces receiving a Level 5 finish.

d. Spray applied coating compound:
   1) Final, skim coat, on surfaces receiving a Level 5 finish.
7. Joint compounds for moisture resistant gypsum wallboard:
   a. Setting type joint compound:
      1) Filling open joints and voids.
      2) Embedding tape and first coat over joints, fasteners and trim flanges.
   b. Lightweight setting type joint compound:
      1) Second and third coats.
      2) Final, skim coat on surfaces receiving a Level 5 finish.

L. Acoustical Materials:
1. Provide where indicated.
2. Minimum nominal thickness: As required to achieve STC indicated for wall systems.
3. Density: As required to achieve STC indicated for wall systems.
4. Sound attenuation batts (SAB):
   a. Glass or mineral fiber.
   b. Commercial sound blanket, ASTM C665, Type I, unfaced, produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   c. Surface burning characteristics per ASTM E84:
      1) Maximum flame spread: 10.
      2) Maximum smoke developed: 10.
   d. Fire rated assemblies: Select SAB materials and thicknesses that that are approved for use in assemblies listed.
   e. Acoustically rated assemblies: Select SAB materials and thicknesses that that are approved for use in assemblies listed.
   f. Base Product: Sound Attenuation Batt Insulation by Owens-Corning.
5. Preformed acoustical seal for wall boxes:
   a. Box Seal by STC Sound Control
   b. Molded neoprene, durometer A-40 complying with ASTM D2000.
   c. Formed to fit the electrical device, outlet and service boxes.
   d. STC improvement: 6 db in accordance to ASTM E90.
   6. Provide at electrical and service box penetrations in sound rated walls.

M. Interior joint sealants, including acoustical sealants:
1. See Section 07 92 16.

N. Fasteners:
1. Bugle head screws: ASTM C1002 for use with maximum 22 GA metal stud framing.
2. Self-tapping bugle head screws: ASTM C954 for use with minimum 20 GA metal framing.
3. Type S for gypsum wallboard to metal; Type G for gypsum wallboard to gypsum wallboard.
4. Screws used with backer boards: As recommended by panel manufacturer.

O. Laminating Adhesive:
1. Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

P. Foam Tape:
1. PVC 1/2 x 1/4 IN: With pressure sensitive adhesive; Norseal.
2. EPDM 1/2 x 1/4 IN: With pressure sensitive adhesive; Cellular rubber by Gasket Dynamics.

Q. Backing for Control Joints:
1. Fire rated board.

R. Support straps:
1. Galvanized steel sheet for retaining and bracing in length and width indicated or as required for adequate support of assembly.

2. Minimum Base-Metal Thickness: 20 GA.

S. Sealer for Moisture Resistant Gypsum Wallboard:
1. Manufacturer's standard compound.
2. Use at joints, cut edges and screw penetrations.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Examine supporting structure and conditions prior to wallboard installation.

B. Correct unsatisfactory conditions.

C. Start of installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Remove loose materials and vacuum cavity of gypsum dust prior to enclosing stud space.

C. Install wallboard vertically with edges over metal stud framing members and similar framing support members.

D. Bring boards into contact but do not force into place.

E. Stagger edge joints on opposite side of partition so they occur on different framing members.

F. Stagger joints in multi-layer applications not less than one support from previous layer.

G. Seal ends, cutouts and screw penetrations of moisture resistant boards with sealer.

H. Install wallboard over metal framing studs and similar framing support members at interior face of exterior walls full height from floor to structure above.

I. Wallboard installation prior to building being weathertight:
1. Replace scheduled GWB products to their mold-resistant counterparts.
a. Products proposed are subject to Architect approval.
2. Exposure time shall be limited by manufacturer requirements.

J. Sound Insulation:
1. Install sound insulation in walls from floor to structure above, where sound rated walls are indicated.
2. Install in thicknesses and densities necessary to achieve sound rating.
3. Fill cavities where studs are installed nested or toe-to-toe.
4. Pack spaces around electric boxes and other penetrations to maintain full sound rating.
a. Fill small voids that remain with Acoustical Sealant.
5. Where walls are not finished on both sides or insulation does not fill the cavity depth, supplementary galvanized steel support straps must be provided to hold product in place at 24 IN on center or at spacing as indicated by the insulation manufacturer's written installation instructions.

K. Preformed Acoustical Seal for Wall Boxes:
1. Place preformed seal over exposed outlet box flush with wall surface with device protruding through preformed or precut opening in seal.
2. Secure in place with outlet cover plate.

L. Curved Partitions:
1. Space studs or furring to prevent flat areas between framing at curved surfaces.

M. Wall Reveals:
1. Install reveal wall channels and/or aluminum framing as recommended by manufacturer.

N. Screw Placement:
1. Proceed with attachment from board center toward ends and edges.
2. Space maximum 8 IN OC at edges and 12 IN OC in field of board.
   a. Use closer screw spacing if required by UL.
   b. Fasten wallboard to each stud where multiple studs are installed at door jambs.
3. Secure wallboard to vertical studs; do not secure to top track directly.
   a. Follow top track manufacturer's screw pattern requirements.
   b. Install additional framing if required.
   c. Top track is specified in Section 09 22 16.
4. Set screws between 3/8 IN and 1/2 IN from edges.
5. Drive screws so head rests in slight dimple without cutting face paper or fracturing core.

O. Access Panels and Doors:
1. Locate where required by Section 20 05 00 and Section 26 00 10, or as indicated.

3.3 INSTALLATION - RADIATION SHIELDING

A. Verify shielding materials meet project requirements prior to installation.

B. Install in accordance with manufacturer's recommendations and U.L. requirements.

C. Perform corrective work to achieve complete radiation isolation, including repair or replacement of finishes.

D. Rear Access:
1. Definition: Lead lined GWB installation is physically possible from both sides of wall.
2. Construct per UL V439 or other approved design when fire rating is indicated.
3. Install lead battens to inside face of stud flange.
4. Screw lead lined wallboard to studs.
5. Space screws 8 IN OC at edges and 12 IN OC in field.
6. Install nominal 2 IN square lead cap crimped over screw points penetrating lead lined wallboard.
7. Install 2 IN wide sheet lead strip behind joints.
   a. Install at door and window frame perimeters.
   b. Overlap lead minimum 1 IN .

E. Front Access:
1. Definition: Lead lined GWB installation is only possible from X-ray Room side of wall.
2. Construct per UL approved design when fire rating is indicated.
3. Install lead battens to inside face of stud flange.
4. Screw lead laminated wallboard to studs.
5. Install lead buttons over screw heads.
6. Adhesively install second wallboard layer.

F. Fire Rated Assembly, UL-U430:
1. 1 Hour.

G. Installation and Protection at Penetrating Items:
1. Penetrations of lead linings: Provide lead shields to maintain continuity of protection.
2. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.
3. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.
4. Cut wall penetration covers from lead sheet of equal or greater thickness than backing on adjacent wall panels and size to cover penetrations with laps 1 IN minimum wide.
5. Adhesive apply lead sheet penetration covers on penetrating boxes and raceways and return penetration covers to backside of lead-backed wall panels with 1 IN minimum laps.

a. Do not use penetrating fasteners unless indicated otherwise.

6. Outlet boxes and conduit:
   a. Cover or line with lead sheet lapped over adjacent lead lining at least 1 IN.
   b. Wrap conduit with lead sheet for a distance of not less than 10 IN from box.
7. Duct openings:
   a. Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition or ceiling or both equal to three times the largest opening dimension.
   b. Lap lead sheet with adjacent lead lining at least 1 IN.
8. Duct Penetrations; where lead sheet 1/8 IN thick and where duct shielding is less than 24 IN wide:
   a. Wrap ducts with wall penetration covers, lapping lead joints 1 IN minimum.
   b. Secure lead sheet in place with 1 IN minimum width steel bands spaced not more than 12 IN on center.
   c. Do not cut into lead sheet with tightening steel bands.
9. Duct penetrations, where lead sheet is greater than 1/8 IN thick or where duct shielding is greater than 24 IN wide:
   a. Laminate wall penetration covers to fire retardant treated plywood or other similar structural panels conforming to shape of duct, lapping lead joints 1 IN minimum.
   b. Secure lead laminated panels to ducts with mechanical fasteners located at duct seams and corners.
   c. Where necessary to prevent lead laminated panels from overloading duct supports, independently suspend panels from hangers secured to overhead building structure.
   d. Cover fastener heads with lead sheet matching thickness of adjacent lead.
10. Piping:
    a. Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 10 IN from point of penetration.

3.4 INSTALLATION - TRIM ACCESSORIES

A. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Interior Trim:
   1. Install in following locations:
      2. Cornerbead: Use at outside corners.
      3. J-Bead or LC-Bead: Use at exposed panel edges.
      4. L-Bead: Use where wallboard abuts dissimilar surfaces and where indicated.

C. Specialty Trim:
   1. Install in locations indicated.

3.5 INSTALLATION - SHAFTWALL

A. Install shaft walls in compliance with UL and Gypsum Association description.

B. Provide shaft wall systems permitting entire erection procedure from outside shaft.

C. Provide special metal runner angles and channels, and studs or splines spaced per manufacturer’s requirements.

D. Comply with requirements for thickness of metal and thickness of wall, for heights of wall indicated.

E. Use maximum practical board lengths.

F. Projections in Elevator Hoistways:
   1. Inspect elevator shafts to determine if projections greater than 4 IN exist.
   2. At projections 4 IN and greater:
      a. Install GWB bevels sloping 75 DEG from horizontal.
      b. Support GWB with metal studs.

3.6 INSTALLATION - CEILING

A. Install in compliance with manufacturer's recommendations.

B. Stagger abutting end joints of adjacent panels' not less than one framing member.

C. During cold or damp weather, insulate before installing gypsum board on a ceiling with a vapor barrier.

3.7 CONTROL JOINTS

A. General:
1. Install Control Joints in location indicated and as described in this article.
2. Install suitable backing material to maintain required rating where Control Joints occur in fire or sound rated assemblies.

B. Partitions:
1. Extend control joints continuous full height of partition or wall.
2. Provide vertical control joints on both wall faces which align with door frames, window frames, and similar opening as follows:
   a. Single Doors and Cased Opening:
      1) Locate CJ's at both jambs, from head of opening to top of partition.
   b. Pair doors:
      1) Locate CJ's at both jambs, from head of opening to top of partition.
      2) Exception: Control Joints are not required where partition forms a cross-corridor condition.
   c. Doors with adjacent sidelights:
      1) Locate CJ's at both jambs from head of opening to top of partition, and, from sill to floor at sidelight jambs.
   d. Sliding doors:
      1) Locate CJ's at both jambs, from head of opening to top of partition.
   e. Punched windows less than 30 FT in width:
      1) Both jambs from head of opening to top of partition, and from sill edge to floor.
   f. Ribbon windows greater than 30 FT in width:
      1) Both jambs from head of opening to top of partition, and from sill edge to floor.
      2) Locate additional intermediate CJ's so maximum distance between CJ's does not exceed 30 FT apart.
3. Provide additional vertical Control Joints, spaced no more than 30 FT apart from each other, from opening related CJ's, or from corners.
4. Provide horizontal control joints at partitions which are more than one story in height:
   a. Locate horizontal Control Joints where partitions bypass each intermediate floor.
   b. Align control joint with floor line, unless otherwise indicated.

C. Ceilings:
1. Use Control Joints to subdivide ceilings/soffits as indicated, and within the following limits:
   a. Ceilings with perimeter relief:
      1) Subdivide so no area exceeds 2500 SQ FT, and no area has a length which exceeds 50 FT.
         a) Exception where ceiling occurs at exterior: Subdivide so that no area exceeds 900 SQ FT, and no area has a length which exceeds 30 FT.
   b. Ceilings without perimeter relief:
      1) Subdivide so that no area exceeds 900 SQ FT, and no area has a length which exceeds 30 FT .
   c. Locate control joints at transitions between areas of different shapes.

D. Soffits:
1. Use control joints to subdivide ceilings/soffits as indicated, and within the following limits:
   a. Locate Control Joints at transitions between areas of different shapes.
   b. Continue lines of soffit Control Joints vertically to top of fascia.

c. Subdivide exterior applications so no area exceeds 900 SQ FT, and no area has a length which exceeds 30 FT.

3.8 WALLBOARD FINISHING

A. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.

B. Pre-fill open joints and voids, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Where bead abuts exterior metal window frames or other metal components, separate from other material by use of foam tape.

E. Remove residual joint compound from adjacent surfaces.

F. Apply Joint Compound and Tape in accordance with fire rated design.
1. Apply joint treatment compound in accordance with manufacturer's directions.
2. Fill joints, screw heads, and internal corners with compound.
3. Extend joint system vertically from floor to extent described as follows:
   a. Fire Walls, Barriers, and Partitions: Extend to full height of wall.
   b. Smoke Barriers and Partitions: Extend to full height of wall.
   c. Interior face of exterior wall (non-rated): Extend to full height of wall.
   d. Other interior partitions (non-rated): Extend to 6 IN 150 MM above ceiling.
4. Refer to Drawings for indication of partition heights.

G. Level 4 Finish:
1. After drying, sand or otherwise smooth final coat of compound as needed to eliminate high spots or excess compound to leave smooth, even, and level surface.
2. Draw down final coat of compound to a smooth even plane.
3. Locations:
   a. Wallboard scheduled to be finished with Gloss Level 1 (flat), Level 2 (velvet), or Level 3 (eggshell) paint, glazed coating, textured coating, or wall covering.
   b. Where above listed surfaces are to be finished with textured decorative treatments, wall covering, paneling, or wall guard.
   c. Remaining locations, unless noted otherwise.

H. Level 5 Finish:
1. Trowel skim coat of joint compound leaving a thin film covering the entire surface, in accordance with manufacturer’s recommendations.
2. Make surfaces free of tool marks and ridges.
3. Locations:
   a. Exposed ceiling, soffit, or wall areas abutting window mullions, skylights, or receiving direct indoor lighting.
   b. Hallways or corridors unbroken by doorways or windows in excess of twenty feet .
   c. Atriums, Lobbies, Auditoriums and similar large spaces.
   d. Multi-story spaces.
   e. Wall board scheduled to be finished with Gloss Level 4 (satin), Level 5 (semi-gloss), Level 6 (gloss), Level 7 (high gloss), paint, glazed coating, textured coating, or wall covering.
   f. Surfaces using MRB or other wallboard types with a glass mat facer on finished side.

I. Glass Mat, Water Resistant Backing Panels:
1. Finish according to manufacturer's written instructions.

J. Cementitious Backer Units:
1. Finish according to manufacturer's written instructions.

K. Repairs:
1. After painter has applied primer to wallboard surfaces, repair and refinish defective areas.
2. If wallboard is damaged, or surfaces are roughened, repair or replace.

3.9 FIRE AND SMOKE WALL IDENTIFICATION

A. Identify walls indicated on Drawings as having a required fire or smoke rating.
1. Follow guidelines set in Chapter 7 of International Building Code.
2. Permanently identify rating and type of barrier with stencil and paint in contrasting, 3 IN high letters in a manner acceptable to authority having jurisdiction.
3. Text for fire and smoke barriers: "x HOUR FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS".

3.10 FIELD QUALITY CONTROL

A. Radiation Shielding Testing:
1. Radiation shielding will be tested by Owner's registered radiation physicist.
2. Notify Owner's radiation physicist when shielding installation is complete to perform a visual inspection.
3. Upon completion of radiology equipment installation, perform tests and radiation survey
a. Comply with requirements of ASTM F2547.
b. Conduct leakage tests under direction of Owner's radiation physicist.
c. Test elements forming radiation shielding.

B. Testing Results:
1. Exposure levels shall not exceed those specified in Radiation Shielding Report.

C. Perform corrective work that inspection reports indicate does not comply with specified requirements.

D. Retest locations where system is found to be deficient following repair.

E. Submit certified reports to Owner.

3.11 PROTECTION

A. Protect installed wallboard from water damage during construction.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

D. Prior to finishing, walls shall be inspected for visible mold growth.
1. Replace affected portions.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILING MATERIALS (AM)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Acoustical Ceiling Systems (AM) in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. ASTM B633Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
   3. ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panels Ceilings.
   4. ASTM C636/C636M Standard Specification for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   5. ASTM E488/E488M Standard Test Methods for Strength of Anchors in Concrete Elements.
   6. ASTM E580/E580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
   7. ASTM E1190 Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members

B. Site Classification and Seismic Design Categories as defined in the International Building Code.

C. South Coast Air Quality Management District Rule 1168 Adhesives and Sealant Applications.

1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's product data that products comply with acoustical properties indicated on Drawing I-600 Interior Notes and Finish Legend.

B. Samples:
   1. Three samples of each type of acoustical ceiling tile (ACT) listed in Drawing I-600 Interior Notes and Finish Legend.

C. Contract Closeout Information:
   1. Maintenance data.
      a. See Section 01 77 00.

1.4 EXTRA MATERIAL

A. Provide 5% of quantity utilized

B. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Suspension Systems:
   1. Base:
      a. Armstrong World Industries.

2. Optional:
   a. USG Corporation
   b. Rockfon

B. Acoustical Ceiling Tile (ACT):
   1. Base:
      a. As noted for individual types in Drawing I-600 Interior Notes and Finish Legend.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Acoustic Suspension Systems:
   1. Heavy duty systems, ASTM C635.
   2. Main runner jointing by spliced, interlocking ends, tab locks, pin locks, or other suitable connections.
   3. Cross runners interlocking with main runners.
   4. Include components and accessories necessary resist seismic loads and dead loads of items such as light fixtures and air diffusers.
   5. Hanger Wire:
      a. Pre-stretched, with a yield stress load of at least 5 times design load, but not less than 0.106 IN (12 GA) .
      b. Utilize continuous lengths, without kinks and splices.
      c. Galvanized Steel:
         1) Galvanized, soft annealed steel wire conforming to ASTM A641/A641m.
      d. Stainless Steel:
         1) Type 304, soft annealed steel wire conforming to ASTM A641/A641M.
         2) Use where aluminum ceiling grid is specified.
   6. Attachment Devices:
      a. Anchors in Concrete:
         1) Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488/A488M or ASTM E1512.
         2) Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
         3) Material: Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 for Class SC 1 service condition.
      b. Power-Actuated Fasteners in Concrete:
         1) Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
   7. Suspension System Types:
      a. CG-1: Exposed grid, non-rated:
         1) Description: Galvanized, double web steel, main and cross runners.
         2) Face width: 15/16 IN .
         3) Base Product:
            a) Prelude XL, by Armstrong.
         4) Finish on exposed surfaces: Smooth, flat white.

B. Acoustical Ceiling Tile:
   1. Scheduled finishes to be factory applied.
   2. Class A incombustible units.
   3. Edges uniformly fabricated, true, square.
   4. Sizes as required to fit scheduled suspension system.

5. Standard tile size: See Reflected Ceiling Plan.
6. Concealed spline style: Edges kerfed for splines.

C. Diffusers and Grilles:
1. See Section 23 31 13.

D. Light Fixtures:
1. See Section 26 51 13.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Examine installation site for irregularities having affect on quality and execution of work.

C. Consult other trades involved before start of ceiling work, to determine areas of potential interference

D. Do not start installation until interferences have been resolved.

E. Installation constitutes acceptance of responsibility for performance.

3.2 PREPARATION

A. Coordinate ceiling layout with sprinkler head spacing and work penetrating acoustical ceiling systems.

B. Tolerances:
1. Comply with ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
2. Deviation from level plane: 1/8 IN in 10 FT with no load applied maximum.
3. Bow: 1/32 IN in 2 FT maximum.
4. Camber: 1/32 IN in 2 FT maximum.
5. Twist: 1 degree in 2 FT maximum.

3.3 INSTALLATION

A. Suspension System:
1. Install suspension system in accordance with manufacturers' instructions.
2. Grid layout:
   a. See Reflected Ceiling Plans.
   b. Install grid based on electrical lighting fixture layout indicated in Electrical Drawings, unless otherwise indicated,
   c. Acoustical panel dimension at perimeter walls: Not less than 6 IN.
   d. In case of conflict notify Architect.
3. Install grid square with room and with grid or acoustical panel center lines coinciding with center lines of room, each direction.
4. Intersections between main tees and cross tees:
   a. Butt cut and notch as required.
5. Wall angles:
   a. Install wall angles or moldings where ceilings meet walls, partitions, vertical elements, and other types of ceilings or ceiling fixtures.
      1) Secure angles to wall construction at stud locations.
         a) Maximum spacing from terminal ends: 3 IN.
         b) Draw fasteners tight against vertical surfaces.
      2) Level tolerance: not more than 1 IN 1000.
      3) Miter cut inside and outside corners.

4) Install with leg supporting bottom flange of runners.

6. Hanger wires:
   a. Provide hangers and inserts necessary to support ceiling suspension systems and ceiling dead loads.
   b. Coordinate location and alignment with work of other trades.
   c. Install hanger wires plumb to main tees and cross tees.
      1) Do not suspend any part of suspension system from ducts, pipes, conduit, cable tray or equipment.
      2) Provide supplementary rough suspension system where necessary to support ceilings beneath pipes, ducts, equipment, cable trays.
      3) Splay hangers no greater than 30 DEG from vertical to avoid obstructions or other conditions that prevent plumb, vertical installation.
      4) Offset horizontal forces by bracing or counter-splaying.
   d. Space hangers to prevent eccentric deflection and rotation due to loads from items in or on ceiling
      1) Provide supplemental hangers to support lighting fixtures and within 6 IN from end of main runners and fixtures which exceed manufacturer's published load data.
      2) Do not bear runners on walls or partitions.
7. Main runners:
   a. Utilize wall angles to align and receive terminal ends of main tees without transferring load to wall angle.
   b. Space main tees as indicated to receive lay-in panels and fixtures.
   c. Support terminal ends of main tees by wires located within 6 IN from boundary walls.
8. Cross runners:
   a. Space cross tees as indicated to receive lay-in panels and fixtures.
      1) Install cross runners with positive interlock.
   b. Utilize wall angles to align and receive terminal ends of cross tees without transferring load to wall angle.
   c. Support terminal ends of cross tees by wires located within 6 IN from boundary walls.
9. Leave suspension system ready to accept installation of acoustic materials.

B. Lay-In Items:
   1. Install acoustic materials in accordance with manufacturer's instructions.
   2. Place lay-in panels, fixtures, diffusers, grilles, and similar items in manner not compromising suspension system performance.
   3. Field cut materials to fit grid.
   4. Ceiling paint:
      a. Touch-up minor surface scratches and blemishes.
      b. Cover field cut edges exposed to view.
      c. Armstrong SuperCoat Ceiling Panel Touch-up Paint.

3.4 CLEANING AND REPAIR

A. Perform cleaning of soiled units and replacement of defective or damaged units.

END OF SECTION

SECTION 09 65 16
RESILIENT SHEET FLOORING (SV)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Sheet Vinyl Flooring (SV), as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Experienced in installation of sheet flooring using heat welded seems.

B. ASTM International (ASTM):
   1. ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish Coated Flooring Surfaces as Measured by the James Machine.
   2. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
   3. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
   4. ASTM F970 Standard Test Method for Static Load Limit.

C. National Fire Protection Association (NFPA):
   1. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
   2. NFPA 258 Recommended Practice for Determining Smoke Generation of Solid Materials.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Seaming Diagram.

B. Product Data:
   1. Manufacturer's product data indicating adhesives comply with applicable VOC regulations.

C. Samples:
   1. Submit samples for following items as specified in Drawing I-600 Interior Notes and Finish Legend.
   2. Three samples of each sheet goods selected.
   3. Three samples of each welding rod.
   4. Full range of welding rod colors, cap strips and other accessories for selection by Architect.

D. Contract Closeout Information:
   1. Warranty
   2. Maintenance data:
      a. See Section 01 77 00.

1.4 EXTRA MATERIAL

A. Deliver extra sheet vinyl flooring to Owner.
   1. Furnish in original boxes, properly marked.
   2. Provide 5% of each type and size specified.

B. See Section 01 77 00.

1.5 WARRANTY

A. Provide written warranty that material will be free from manufacturing defects for a period of five (5) years from date of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Sheet Vinyl Flooring (SV):
   1. Base:
      a. Mannington Commercial Resilient; BioSpec MD.
   2. Optional:
      a. Johnsonite: A Tarkett Company.
      b. Armstrong World Industries; Medintech.

B. Fire and Smoke Rating:
   1. Critical Radiant Flux, per ASTM E648 / NFPA 253:
      a. Class I, not less than 0.45 W/cm2.
   2. Smoke Developed: 450 or less per ASTM E662 / NFPA 258.

C. Cap Strip:
   1. Base:
      a. Roppe.
      b. Johnsonite: A Tarkett Company.

2.2 MATERIALS

A. Resilient Sheet Vinyl (SV) flooring:
   1. Solid polyvinyl chloride sheet floor covering, minimum 0.080 IN overall thickness.
   2. ASTM Standard:
      a. ASTM F1913.
   3. Static coefficient of friction: 0.6.
   4. Static Load Limit:
      a. 750 PSI.

B. Integral Coved Base:
   1. Height: 4 IN.
   2. Extend the flooring material up the wall supported by a cove filler strips having a minimum height of 7/8 IN and adhering to the wall.
   3. Metal cove cap strip:
      a. Material: Aluminum or not corrosive metals suitable for conditions.
      b. Static Conductive applications: Properly ground metal caps or use Plastic Caps.
      c. MRI Rooms: Use Plastic Caps (in lieu of metal) for MRI Scan Rooms.

C. Sealers:
   1. Provide sealers as recommended by flooring manufacturer.

D. Adhesive:
   1. Provide adhesives as recommended by flooring manufacturer.

E. Leveling Compound:
   1. Cementitious type as recommended by flooring manufacturer.
   2. Verify compatibility with moisture content of concrete.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces for defects, irregularities and conditions under which flooring is to be installed.

B. Verify substrates are free of materials that may affect adhesion.

C. Identify cracks and other surface defects which need repair prior to application of floor system.

D. Inspect substrate for markers, paint and similar materials used for layout by others and take remedial action as necessary to remove layout line work to prevent bleed-through.

E. Verify floors are level or meet indicated slope.

F. Do not proceed with installation until unsatisfactory conditions have been corrected.

G. Installation indicates acceptance of substrates and responsibility for performance.

3.2 PREPARATION

A. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing, and Section 07 16 05 Water Vapor Emission Control System.

B. Prepare substrate in accordance with manufacturer's instructions.

C. Fill construction joints and other non-moving joints with product approved by manufacturer of flooring system.

D. Where necessary fill or level floors with leveling compound and feather minimum 4 FT- 0 IN.

E. Coordinate leveling with vapor emission control system provider.

3.3 INSTALLATION

A. Apply flooring in accordance with manufacturer's printed instruction.

B. Install flooring and base as indicated for rooms:
   1. Include area under and behind equipment.
   2. Provide integral coved base for walls, columns, pilasters, furred spaces, and casework, etc.

C. Minimize accumulation of air contaminants that cannot be removed prior to occupancy.

D. Install after wall finishes.

E. Provide sheets in one room or area from one production run.

F. Install in maximum possible sizes.

G. Install in adhesive with accurate, tight seams.

H. Weld to adjacent vinyl sheet flooring and weld joints between sheets.

I. Remove excess rod with sharp knife and buff to match adjacent surfaces.

J. Locate transition strip directly under door when in closed position where seam occurs in door openings.

K. Utilize transition strip specified in respective section where abutting materials are carpet, ceramic tile, quarry tile, stone tile and similar.

L. Where sheet vinyl flooring abuts thicker finish flooring materials, feather leveling compound for approximately 12 IN for each 1/8 IN of rise so finished surfaces align.

3.4 PROTECTION

A. Restrict heavy traffic for 48 HRS.

B. Do not expose to water for 30 days.

C. Protect floors from rolling loads by covering with hardboard or plywood.

D. Protect the floor with un-dyed, untreated building paper until final inspection.

3.5 CLEANING

A. When final building cleanup is being accomplished clean flooring and base in accordance with manufacturer's instructions.

END OF SECTION

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Exterior Painting, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Definitions:
1. "Paint" and "painting" refer to applied coatings.
2. Mechanical work and equipment: Work included in Mechanical Specification Divisions.
3. Electrical work and equipment: Work included in Electrical Specification Divisions.

B. Work Included:
1. Exterior surfaces scheduled to be painted, unless indicated to be painted under other Sections.
2. Exposed exterior and on-site concrete masonry unit surfaces, including areaway walls, backside faces of parapets, screen walls, and retaining walls.
3. Mechanical and electrical work:
   a. Exterior equipment and items not completely factory finished.

C. Surfaces not to be painted:
1. Colored, split-face, patterned, ground-face, glazed, and other concrete masonry units with integral architectural finish.
2. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
3. Moving parts of valves, operating units, mechanical and electrical parts, such as valve and damper operators, sending devices, motor and fan shafts.
4. Code labels, such as UL, FM that are Mylar or flat, non-embossed, plates.
   a. Embossed plates and labels stamped into frames will be painted, label and information on label to be readily visible and convenient for identification by authority having jurisdiction.
5. Equipment identification or rating plates.
6. Items having complete factory finish with exception of:
   a. Exterior mechanical equipment.
   b. Exterior electrical equipment.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer's data for each paint type to be applied indicating conformance to specifications.

B. Samples:
1. Manufacturer’s full palate of colors for selection by Architect.
2. Colors of paint called out as color to match existing to be submitted to architect for review and approval. All exterior paints to be two coat systems.
3. Provide three 8 1/2 IN x 11 IN samples of each color and finish selected.
4. MPI Gloss samples.

C. Contract Closeout Information:
   1. Maintenance data:
      a. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide paint as product of one manufacturer as far as possible.

B. Paint, stain, and coating systems listed are Sherwin Williams unless noted otherwise.
   1. Use comparable performance and aesthetic requirements for Paints by Optional manufacturers.

C. Paints:
   1. Base:
      a. Sherwin-Williams.
   2. Optional:
      a. Benjamin Moore.
      b. PPG Paints.
      c. Pratt & Lambert.
      d. Tnemec.

D. Stains:
   1. Base:
      a. Sherwin-Williams.
   2. Optional:
      a. Benjamin Moore.
      b. PPG Paints.
      c. Pratt & Lambert.

E. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Paints and Stain Systems:
   1. Paint, stain, and coating systems listed are Sherwin-Williams unless noted otherwise.
   2. Colors:
      a. As selected by Architect from manufacturer's full palate and as indicated in Section 20 05 53.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces for defects and correct to prevent unsatisfactory results.

B. Verify compatibility of intermediate and topcoat finishes applied over surfaces primed by others.

C. Commencement of work constitutes acceptance of surfaces and responsibility for performance.

3.2 PREPARATION

A. Verify surfaces are clean, dry and free of foreign materials which will affect adhesion or appearance.

B. Remove mildew and neutralize surface.

C. Eliminate efflorescence before painting.

D. Prior to painting, test surfaces with moisture meter.
   1. Paint when moisture is within paint manufacturer's acceptable limits.

E. Wood:
1. Immediately before applying finish:
   a. Sand surfaces with 180 grit or finer sandpaper, as necessary to accomplish the following:
      1) Smooth surface texture.
      2) Prepare grain to receive finish.
   b. Remove dust.
2. Opaque Finishes:
   a. After priming coat has dried, seal knots, pitch and resinous sapwood.
3. Stained and Clear Finishes:
   a. Treat wood with compatible wash-coat prior to stain application.
   b. Putty nail holes and minor defects, to match wood color.

F. Ferrous Metal and Hollow Metal:
1. Follow requirements of SSPC SP1 and SP3.
   a. Except where higher prep levels are indicated.
2. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
3. Touch up damaged shop coats.
4. For surfaces with touched up shop coat, omit first coat.
5. Hollow metal frame joints at intersections of Rabbets, Stops, and Soffit Joints:
   a. Neatly fill corner seam with painter's caulk (in field) prior to painting.

G. Galvanized Metal and Non-anodized Aluminum:
1. Follow requirements of SSPC SP1.
2. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.

H. Gypsum Wallboard:
1. Repair minor irregularities left by finishers.
2. Exercise care to avoid raising nap of paper.
3. Apply prime coat.
4. Notify gypsum wallboard finisher to repair and refinish areas which indicate defects after application of primer.
5. Re-prime refinished areas.

I. Concrete and Masonry:
1. Repair minor defects.
2. Remove oil from concrete by washing with xylol.

J. Block Filler:
1. Apply masonry to fill pinholes and minor surface defects, and to prime surface for topcoat.
2. Apply by brush, roller or sprayer.
   a. Where spray-applied: Back-roll with roller or squeegee.
3. Minimum Nominal Thickness: 10 MIL DFT.
   a. Comply with manufacturer’s recommended coverage rates for conditions encountered.
4. Provide complete cover with recommended coating system.

K. Obtain architect's approval of finish for surfaces to receive high build glazed coatings.

3.3 APPLICATION

A. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items, or provide ample in place protection.

B. Touch up abraded areas of shop prime coats, suction or hot spots in plaster, gypsum wallboard, concrete block, and concrete before painting.

C. Provide coverage to hide.
1. Evenly spread and smoothly flow on for full, smooth cover.

2. Apply additional coats where undercoats show until paint film is of uniform finish and color.

D. Back prime wood trim with penetrating sealer.

E. Apply additional coats in accordance with manufacturer's instructions.

F. Finish closets and semi-exposed surfaces to match nearest adjoining surfaces.
1. Include surfaces behind grills.

G. Upon completion of painting, replace removed items and remove protection.

H. Finish colors not indicated shall be selected by Architect from paint manufacturer's standard colors.

3.4 PROTECTION AND CLEANUP

A. Provide WET PAINT signs.

B. Protect adjacent work from damage by painting and finishing work.

C. Remove temporary protective wrappings, after completion of operations.

D. Clean, repair or replace, and repaint damaged work.

3.5 EXTERIOR PAINT SYSTEMS

A. Concrete, Concrete Block and GFRC:
1. Latex, Gloss Level 4, Satin:
a. Sherwin-Williams:
1) Prime coat: Loxon Concrete and Masonry Primer.
2) Topcoat: Duration Exterior Acrylic Latex, Satin.
2. Elastomeric, smooth:
a. Sherwin-Williams:
1) Prime coat: Loxon Concrete and Masonry Primer.
2) Intermediate coat: ConFlex XL Elastomeric High Build Coating, Smooth.
3) Topcoat: ConFlex XL Elastomeric High Build Coating, Smooth.
3. Elastomeric, textured:
a. Sherwin-Williams:
1) Prime coat: Loxon Concrete and Masonry Primer.
2) Intermediate coat: ConFlex XL Elastomeric High Build Coating, Smooth.
3) Topcoat: ConFlex XL Texture Elastomeric High Build Coating, Medium.
4. Waterproof:
a. Sherwin-Williams:
1) Prime coat: Loxon Block Surfacer, as needed, or Loxon Conditioner, as needed.
2) Intermediate coat: Loxon XP Waterproofing System.
3) Topcoat: Loxon XP Waterproofing System.

B. Plaster:
1. Elastomeric, smooth:
a. Sherwin-Williams:
1) Prime coat: Loxon Concrete and Masonry Primer.
2) Intermediate coat; ConFlex XL Elastomeric High Build Coating, Smooth.
3) Topcoat: ConFlex XL Elastomeric High Build Coating, Smooth.
2. Elastomeric, textured:
a. Sherwin-Williams:
1) Prime coat: Loxon Concrete and Masonry Primer.
2) Intermediate coat: ConFlex XL Elastomeric High Build Coating, Smooth.
3) Topcoat: ConFlex XL Textured Elastomeric High Build Coating, Medium.

C. Direct-Applied Exterior Finish System (DEFS) Soffits:
   1. Latex, Gloss Level 4, Satin:
      a. Sherwin-Williams:
         1) Prime coat: Loxon Concrete and Masonry Primer.
         2) Intermediate coat: Duration Exterior Acrylic Latex, Satin.
         3) Topcoat: Duration Exterior Acrylic Latex, Satin.

D. Metal Doors, Frames and Miscellaneous Metals - Ferrous, Primed, Zinc-coated, and Aluminum:
   1. Water based urethane, Gloss Level 4, Satin:
      a. Sherwin-Williams:
         1) Prime coat: Pro Industrial Pro-Cryl Universal Acrylic Primer.
         2) Intermediate coat: Waterbased Acrolon 100 Urethane, Satin.
         3) Topcoat: Acrolon 100 Urethane, Satin.

E. Metal Stairs, Handrails, and Guardrails - Ferrous, Primed, Zinc-coated, and Aluminum:
   1. Water based urethane, Gloss Level 6, Gloss:
      a. Sherwin-Williams:
         1) Prime coat: Pro Industrial Pro-Cryl Universal Acrylic Primer.
         2) Intermediate coat: Waterbased Acrolon 100 Urethane, Gloss.
         3) Topcoat: Waterbased Acrolon 100 Urethane, Gloss.

F. Wood:
   1. Sherwin-Williams:
      a. Latex, Gloss Level 4, Satin:
         1) Prime coat: Duration Exterior Acrylic Latex, Satin.
         2) Top coat: Duration Exterior Acrylic Latex, Satin.

G. Stained Wood:
   1. Sherwin-Williams:
      a. Vertical Elements:
         1) Prime coat: WoodScapes Exterior Polyurethane Semi-Transparent Stain.
         2) Topcoat: WoodScapes Exterior Polyurethane Semi-Transparent Stain.
      b. Horizontal Elements:
         1) Prime coat: Duckback SuperDeck Exterior Oil Based Semi-Transparent Stain.
         2) Topcoat: Duckback SuperDeck Exterior Oil Based Semi-Transparent Stain.

END OF SECTION

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SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Interior Painting, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Definitions:
1. "Paint" and "painting" refer to applied coatings, except Section 09 91 13.
2. Finished room or space: Room or space indicated to receive a finish on Drawing I-001 Interior Notes & Finish Legend.
3. Mechanical work: Work included in Mechanical Specification Divisions.
4. Electrical work: Work included in Electrical Specification Divisions.

B. Work Included:
1. Interior surfaces in finished rooms or spaces, unless indicated not to be painted or indicated to be painted under other Sections.
2. Mechanical and electrical work:
   a. Interior mechanical and electrical equipment not completely factory finished.
   b. In finished rooms and spaces: Exposed ductwork, piping, insulated piping, conduit, busways, raceways, and associated accessories.
   c. Where duct surfaces are visible through grilles or diffusers, paint visible surfaces of ducts flat black.

C. Surfaces Not to be Painted:
1. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
2. Moving parts of valves, operating units, motor and fan shafts, sending devices or mechanical and electrical parts such as valve and damper operators.
3. Code labels, such as UL, FM that are mylar or flat, non-embossed plates.
   a. Embossed plates and labels stamped into frames are to be painted.
   b. Information shall be readily visible and convenient for identification by authority having jurisdiction.
4. Equipment identification or rating plates.

D. Factory Finishing of Wood Items Specified Elsewhere:
1. Flush Wood Doors: See Section 08 14 16.

E. ASTM International (ASTM):
1. ASTM D2486 Standard Test Method for Scrub Resistance of Interior Latex Flat Wall Paints.
2. ASTM D2805 Standard Test Method for Hiding Power of Paints by Reflectometry.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer's data for each paint system specified.

B. Samples:
1. Three 8 1/2 IN x 11 IN samples of each color and finish as noted in Drawing I-001 Interior Notes and Finish Legend.

2. Gloss samples.

C. Contract Closeout Information:
1. Maintenance data:
a. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Paints:
1. Base:
a. Sherwin-Williams
2. Optional:
a. Benjamin Moore
b. PPG Paints
c. Pratt & Lambert

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Manufacturers listed as noted in Drawing I-001 Interior Notes and Finish Legend are for color reference only.

B. Provide paint products from one manufacturer as far as possible.

C. Paints and Stain Systems:
1. Paint, stain, and coating systems are by Sherwin-Williams unless noted otherwise.

D. Colors:
1. As noted in Drawing I-001 Interior Notes and Finish Legend and as indicated in Section 20 05 53.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces for defects and correct to prevent unsatisfactory results.

B. Verify compatibility of intermediate and topcoat finishes applied over surfaces primed by others.

C. Commencement of work constitutes acceptance of surfaces and responsibility for performance.

D. Do not paint items having complete factory finish with exception of items noted in Drawing I-001 Interior Notes and Finish Legend and as indicated in Section 20 05 53.

3.2 PREPARATION

A. Verify surfaces are clean, dry and free of foreign materials which will affect adhesion or appearance.

B. Remove mildew and neutralize surface.

C. Eliminate efflorescence before painting.

D. Prior to painting, test surfaces with moisture meter.
1. Paint when moisture is within paint manufacturer's acceptable limits.

E. Wood:
1. Sand surfaces receiving finish with 180-grit, or finer sand paper.
a. Remove fingerprints and marks.
b. Produce smooth texture.

c. Prepare grain to receive finish.
2. Remove dust.
3. Opaque Finishes:
   a. Back prime wood trim with penetrating sealer.
   b. Seal knots, pitch and resinous sapwood.
4. Stain and Clear Finishes:
   a. Treat wood with compatible washcoat prior to stain application.
   b. Putty nail holes and minor defects, to match finish wood color.

F. Ferrous Metal and Hollow Metal:
1. Follow requirements of SSPC SP1 and SP3 except where higher preparation levels are indicated.
2. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
3. Touch up damaged shop coats.
4. Caulk hollow metal frame joints, corner seams, intersections of rabbets, stops, and soffit joints prior to painting.

G. Galvanized Metal and Non-anodized Aluminum:
1. Follow requirements of SSPC SP1 except where higher preparation levels are indicated.
2. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.

H. Gypsum Wallboard:
1. Repair minor irregularities.
2. Avoid raising nap of paper.
3. Apply prime coat.
4. Correct areas showing defects after application of primer.
5. Re-prime refinished areas.

I. Concrete and Masonry:
1. Repair minor defects.
2. Remove oil from concrete.
3. Block Filler:
4. Comply with manufacturer's recommended coverage rates for conditions encountered.
5. Provide complete cover with recommended coating system.
6. Fill pinholes and minor surface defects.
7. Apply by brush, roller or sprayer.
   1) Back-roll spray applied filler with roller or squeegee.

3.3 APPLICATION

A. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items, or provide ample in place protection.

B. Touch up abraded areas of shop prime coats, suction or hot spots in plaster, gypsum wallboard, concrete block, and concrete before painting.

C. Provide coverage to hide.
1. Evenly spread and smoothly flow on for full, smooth cover.
2. Apply additional coats where undercoats show until paint film is of uniform finish and color.

D. Back prime wood trim with penetrating sealer.

E. Apply additional coats in accordance with manufacturer's instructions.

F. Finish closets and semi-exposed surfaces to match nearest adjoining surfaces.
1. Include surfaces behind grills.

G. Upon completion of painting, replace removed items and remove protection.

3.4 PROTECTION AND CLEANUP

A. Provide WET PAINT signs.

B. Protect adjacent work from damage by painting and finishing work.

C. Remove temporary protective wrappings, after completion of operations.

D. Clean, repair or replace, and repaint damaged work.

3.5 INTERIOR PAINT SYSTEMS

A. Concrete and Concrete Masonry Walls:
1. Latex (PNTLO), Gloss Level 3, Eggshell:
   a. Sherwin-Williams:
      1) Prime coat: Loxon Concrete & Masonry Primer.
      2) Intermediate coat: Harmony Interior Latex Eg-Shel.
      3) Topcoat: Harmony Interior Latex Eg-Shel.
2. Latex (PNTL), Gloss Level 2, Velvet:
   a. Sherwin-Williams:
      1) Prime coat: Loxon Concrete & Masonry Primer.
      2) Intermediate coat: ProMar 200 Zero VOC Interior Latex Low Sheen.
      3) Topcoat: ProMar 200 Zero VOC Interior Latex Low Sheen.
3. Stain Resistant (PNTSR), Gloss Level 4, Satin:
   a. Sherwin-Williams:
      1) Prime coat: Loxon Concrete & Masonry Primer.
      2) Intermediate coat: Duration Home Interior Latex Satin.
      3) Topcoat: Duration Home Interior Latex Satin.
4. Epoxy (PNTE), Gloss Level 6, Gloss:
   a. Sherwin-Williams:
      1) Prime coat: Loxon Concrete & Masonry Primer.
      2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
      3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.

B. Gypsum Wallboard and Plaster Surfaces, Walls:
1. Latex (PNTL), Gloss Level 3, Eggshell:
   a. Sherwin-Williams:
      1) Prime coat: Harmony Interior Latex Primer.
      2) Intermediate coat: Harmony Interior Latex Eg-Shel.
      3) Topcoat: Harmony Interior Latex Eg-Shel.
2. Low Odor (PNTLO), Gloss Level 3, Eggshell:
   a. Sherwin-Williams:
      1) Prime coat: Harmony Interior Latex Primer.
      2) Intermediate coat: Harmony Interior Latex Eg-Shel.
      3) Topcoat: Harmony Interior Latex Eg-Shel.
3. Stain Resistant (PNTSR), Gloss Level 4, Satin:
   a. Sherwin-Williams:
      1) Prime coat: Harmony Interior Latex Primer.
      2) Intermediate coat: Duration Home Interior Latex Satin.
      3) Topcoat: Duration Home Interior Latex Satin.
4. Epoxy (PNTE), Gloss Level 6, Gloss:
   a. Sherwin-Williams:
      1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
      2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
      3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.

C. Gypsum Wallboard - Ceilings and Soffits:
   1. Latex (PNTL), Gloss Level 1, Flat:
      a. Sherwin-Williams:
         1) Prime coat: Harmony Interior Latex Primer.
         2) Intermediate coat: Harmony Interior Latex, Flat
         3) Topcoat: Harmony Interior Latex, Flat.
   2. Low Odor (PNTLO), Gloss Level 1, Flat:
      a. Sherwin-Williams:
         1) Prime coat: Harmony Interior Latex Primer.
         2) Intermediate coat: Harmony Interior Latex, Flat
         3) Topcoat: Harmony Interior Latex, Flat.
   3. Stain Resistant (PNTSR), Gloss Level 1, Flat:
      a. Sherwin-Williams:
         1) Prime coat: Duration Home Interior Acrylic Latex.
         2) Intermediate coat: Duration Home Interior Acrylic Latex, Matte.
         3) Topcoat: Duration Home Interior Latex Matte, A96-100.
   4. Epoxy (PNTE), Gloss Level 3, Eggshell:
      a. Sherwin-Williams:
         1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
         2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Eg-Shel.
         3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Eg-Shel.

D. Concrete Floors:
   1. Epoxy:
      a. Sherwin-Williams:
         1) Prime coat: ArmorSeal Floor-Plex 7100 Water Based Epoxy Primer.
         2) Intermediate coat: ArmorSeal Floor-Plex 7100 Water Based Epoxy.
         3) Topcoat: ArmorSeal Floor-Plex 7100 Water Based Epoxy.

E. Metal Stairs, Handrails, Guardrails and Miscellaneous Metals - Ferrous, Primed, Zinc-coated, and Aluminum:
   1. Waterborne epoxy, Gloss Level 6, Gloss:
      a. Sherwin-Williams:
         1) Prime coat: Pro Industrial Pro-Cryl Universal Primer.
         2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
         3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.

F. Duct Surfaces Visible Through Grilles or Diffusers:
   1. Interior Latex Gloss Level 1 Flat:
      a. Sherwin-Williams:
         1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
         2) Topcoat: ProMar 200 Interior Latex, Flat.
            a) Color: Black.

G. Metal Doors and Frames:
   1. Waterborne epoxy, Gloss Level 5 Semi-gloss:
      a. Sherwin-Williams:
         1) Prime coat: Pro Industrial Pro-Cryl Universal Primer.
         2) Intermediate coat: Pro Industrial Pre-Catalyzed Water Based Epoxy, Semi-Gloss.
         3) Topcoat: Pro Industrial Pre-Catalyzed Water Based Epoxy, Semi-Gloss.

H. Painted Wood:
   1. Gloss Level 3, Eggshell:
      a. Sherwin-Williams:
         1) Prime coat: Premium Wall & Wood Primer.
         2) Intermediate coat: ProMar 200 Zero VOC Interior Latex Eg-Shel.
         3) Topcoat: ProMar 200 Zero VOC Interior Latex Eg-Shel.

I. Stained Wood:
   1. Stain:
      a. Sherwin-Williams:
         1) Wood Classics 250 Interior Oil Stain.
   2. Clear intermediate and topcoats:
      a. Premium quality.
         1) Comply with current edition of AWI Architectural Woodwork Quality Standards.
      b. Sheen:
         1) Measured with 60 degree gloss meter.
         2) Satin: 31 to 45 points.
      c. Apply product in 2 coats.
         1) Lightly sand between coats.
      d. Polyurethane based Varnish:
         1) Sherwin-Williams:
            a) Wood Classics Polyurethane Varnish.

END OF SECTION

SECTION 10 14 23
SIGNS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services required for fabrication and installation of Signs as indicated in the drawings.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. 2010 ADA Standards for Accessible Design.

B. American National Standards Institute, ICC/ANSI A117.1.

1.3 SUBMITTALS

A. Samples:
   1. Color and font samples for approval.

1.4 WARRANTY

A. Manufacturer shall warrant workmanship and materials for a period of two (2) years.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Signs:
   1. Base:
      a. Poblocki Sign Company.
   2. Optional:
      a. Mohawk Sign Systems.
      b. ASI Sign Systems.
      c. Best Manufacturing Sign Systems.
      d. Innerface Architectural Signage.
      e. InPro Corporation.
   3. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Signs:
   1. Three-ply plastic laminate, 1-1/2 IN wide x length required for script.
   2. Nominal letter height: 3/4 IN .
   3. Letters and numbers: Raised 1/32 IN.
   4. Uppercase.
   5. Letter style: Sans serif.
   6. Color: As selected.
      a. Characters: Dark.
      b. Background: Light.
   7. Finish: Nonglare.
   8. Bevel edges.
   9. Letters shall conform to following proportional standard:
      a. The font width of uppercase letter “O” shall be 55 PCT minimum and 110 PCT maximum height of uppercase letter “I”.

b. Stroke thickness of uppercase letter "I" shall be 10 PCT minimum and 30 PCT maximum height of character.

10. Tactile lettering shall conform to following standards:
    a. Character height measured vertically from the baseline of character shall be 5/8 IN minimum and 2 IN maximum based on height of uppercase letter “I”.
    b. Stroke thickness of uppercase letter "I" shall be 15 PCT maximum height of character.
    c. The font width of uppercase letter “O” shall be 55 PCT minimum and 110 PCT maximum height of uppercase letter “I”.
    d. Maintain minimum 1/8 IN font separation between characters.
11. Braille characters shall conform to the following standard:
    a. Braille characters shall be separated from adjacent raised characters or symbols 1/2 IN.
    b. Grade 2 Braille translation to be provided by identification device manufacturer.

B. Directional and identification signs for communications systems: International symbols.

C. Adhesive: 3M double-coated urethane foam tape.
1. 4032 for smooth surfaces.
2. 4016 for rough surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location:
1. Single doors: Install on wall adjacent to latch side of door.
2. Double doors: Install on nearest adjacent wall.

B. Mount 5 FT above finish floor to centerline of sign.

C. Mount using adhesive tape.

3.2 SCHEDULE

A. Provide signs as follows:
1. "Stair" at each floor, each stair.
2. "Mechanical Room" at each mechanical space door.
3. "Men" at each men's toilet.
4. "Women" at each women's toilet.
5. "Janitor" at each janitors closet.
6. "Electrical" at each electrical closet.

B. Provide signs at elevator call stations directing use of stairs: See ASME-A17.1, Appendix H.

C. Provide stair identification sign in enclosed stairs connecting three or more stories.
1. See both IBC and NFPA for features of sign.

D. Provide international accessibility symbols at:
1. Accessible entrance.
2. Accessible exit.
3. Accessible toilets.
4. At inaccessible elements, provide directional signage to indicate route to nearest accessible element.

E. Provide directional and identification signs for:
1. Assistance listening systems.

END OF SECTION

SECTION 11 53 43
LABORATORY SERVICE FITTINGS AND FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Laboratory Service Fittings and Fixtures, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SECTION INCLUDES

A. Laboratory service fittings, valves, electrical pedestal boxes, and related components.

B. Laboratory sinks.

1.3 QUALITY ASSURANCE

A. Unless specified otherwise, because of special coordination requirements, the scope of work described in this Section shall be provided by the supplier of the Section 12 35 53 scope of work.

B. Work in this Section requires close coordination with Work in Section 12 35 53, Division 22 Plumbing, Division 23 HVAC and Division 26 Electrical.
   1. Coordinate Work to assure an orderly progress in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.

C. Review conditions of installation, procedures and coordination with related Work.

D. Carefully inspect the installed Work specified in other Sections and verify that Work is complete and ready for the installation of this Work to properly commence.

E. Install Work in accordance with original design, reviewed submittals and manufacturer's recommendations.

F. Manufacturer and Installer Qualifications:
   1. Five (5) years documented experience specializing in manufacture of type of equipment specified, with demonstrated ability to produce the specified equipment of required quality and quantity for complete installation in a project of this type and size within required time limits.
   2. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.

G. Conform to the recommended practices for laboratory service fittings and fixtures published by the Scientific Equipment and Furniture Association (SEFA) 7: Fixtures, current version.

H. Where identified, service fittings and sinks shall be accessible to the disabled in compliance with the requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations.

1.4 SUBMITTALS

A. Product Data:
   1. Submit complete materials list, including catalogue data of materials, equipment, and products for Work in this Section.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. Operating and maintenance manuals describing operating and maintenance procedures.
      b. Maintenance and replacement schedules.

c. Components parts list.
d. Nearest local factory representative for components and repairs.
e. See Section 01 77 00.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fittings and fixtures to job site in recommended packaging, with each fitting individually packaged, marked, and scheduled for point of use.

B. Inventory fittings, at job site, verify that type and quantity are correct, and re-package until installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Service fittings and emergency plumbing fixtures shall be designed for laboratory use.

B. Service fittings and emergency plumbing fixtures shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.

C. Laboratory service fittings shall be the product of one service fitting manufacturer to assure ease of replacement and maintenance.

D. Service valves, fittings, and accessories shall be of cast brass with a minimum copper content of 85 PCT, except for items which are to be brass forging or bar stock, or are specifically specified to be of another material.

E. Assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles and straight serrated hose ends shall be made from solid brass stock.

F. Replaceable seats, needle cones, valve disc screws and other accessories shall be Monel or stainless steel alloys especially selected for use intended.

G. Fittings shall be factory tested and shall be supplied with nipples, lock nuts, shanks, etc.

H. Serrated tip fittings shall have 3/8 IN IPS thread with the hose end being tapered. Diameter of orifice in serrated tip shall be 1/8 IN, except where otherwise specified.

I. Turrets shall be brass drop forging of design indicated in details shown elsewhere in the Section and shall be one or two-way, as required, with 3/8 IN IPS female inlet thread for connections.
   1. Units shall be furnished with brass shanks, brass locknuts, and washers.

J. Fittings located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform related appearance, regardless of valve type construction.

K. Flanges shall be brass forging of approved design with 3/8 IN IPS female inlet and outlet.

L. Goosenecks shall provide full thread for attachment of anti-splash outlet fittings, serrated tips, and filter pumps.

M. Hot water/cold water gooseneck mixers and wall-mounted cold water goosenecks shall swivel.
   1. Swivel point shall be at turret or at valve level if wall mounted.
   2. Swing joints shall have heavy Teflon type packings.
   3. O rings will not be permitted.

N. Fittings shall have plastic colored service index buttons.

O. Provide durable 2-3/4 IN tall x 5 IN wide sign NONPOTABLE WATER - NOT SAFE FOR DRINKING or signage as required in the plumbing code of the Authority Having Jurisdiction, at each bench- and panel-mounted industrial (laboratory, protected) water faucet.
   1. Letters shall be a minimum of 1/2 IN high.

2.2 LABORATORY SERVICE FITTINGS

A. Laboratory service fittings specified in this Section shall be provided by a single manufacturer.

B. Manufacturers:
   1. Base:
      a. Water Saver Faucet Co.
   2. Optional:
      a. T&S Brass and Bronze Works, Inc.
      b. The Chicago Faucet Company.
   3. Other manufacturers desiring approval comply with Section 01630.

C. Body Profile:
   1. Service fittings shall have cylindrical body profiles.
      a. Mushroom profile not allowed.
      b. Turrets shall be provided without deck flanges.

D. Handles:
   1. Locations designated to be accessible to the disabled (ADA).
      a. Water faucets: wrist-blade handles with screw on index identification discs.
   2. Other fittings shall be fitted with color-coded hooded type handles with screw-on index discs.

E. Finish: Satin Nickel, with clear, acid-resistant (epoxy) coating; refer to Finishes article below for requirements.

F. Water Valves:
   1. General:
      a. Water fixtures shall be fully assembled and factory tested at 80 PSI water pressure.
      b. Water valves shall include a renewable unit containing working parts which are subject to wear, including stainless steel or monel seat, monel screw and heavy duty seat disk and Teflon packing, and an integral adjustable volume control.
      c. Unit shall be convertible from compression to self-closing, and vice versa, without disturbing faucet body proper and shall also be convertible from water construction to needle valve or steam valve construction having outside packing gland without disturbing faucet body.
      d. Unit shall be sealed in valve body with special composition gasket.
         1) Metal-to-metal or ground joint type of sealing is not acceptable.
      e. Exposed metal shall be finished as specified elsewhere in this Section.
      f. Water service fixtures shall satisfy the requirements of ANSI/ASME A 112.18.1M and be certified by the Canadian Standards Association (CSA) under Standard CAN/CSA B.125.M89.
   2. HCW2: Bench-mounted, hot and cold water faucet.
      a. Base Product: Water Saver LA422-8-BH.
      b. Wrist blade handles .
      c. Renewable water valves and deck-mounted valve body.
      d. Swing gooseneck with 8 IN spread.
      e. Removable aerator.
         1) Aerator should terminate approximately 3 IN above deck.
      f. Threaded mounting with locknut, washer, and coupling nuts.
      g. Adjustable volume control.
         1) Design flowrate: 1.0 GPM.
      h. Accessible to the disabled.

G. Service Fitting Color Index: for colored plastic index buttons:

Service Name	Disc Color	Letters	Color
Industrial (Laboratory) Cold Water	Dark Green	ICW	White
Industrial (Laboratory) Hot Water	Red	IHW	White
Cold Water (Potable)	Dark Green	CW	White
Hot Water (Potable)	Red	HW	White

2.3 FINISHES

A. Satin Nickel Finish with Clear Epoxy Coating:
   1. Applicable to:
      a. Laboratory service fittings except fittings inside fume hoods.
      b. Laboratory service fittings mounted on stainless steel work surfaces, scullery sinks, hand or service sinks, or other stainless steel laboratory furnishing item or equipment.
   2. Satin Nickel Finish:
      a. Exposed surfaces shall be polished and electroplated with one layer of nickel.
      b. Exposed surfaces shall then be further polished to an ANSI No. 6 brushed finish that is fine-grained and uniform.
   3. Clear epoxy coating:
      a. Following plating, exposed surfaces shall be cleaned and degreased.
      b. Clear epoxy coating shall be applied to exposed surfaces and then baked to permit curing.
      c. Surfaces shall have a minimum coating thickness of 3 mils.

B. Performance requirements for coated finishes:
   1. Chemical resistance:
      a. Fume Test:
         1) Suspend coated samples in a container of at least 6 FT3 capacity, approximately 12 IN above open beakers, each containing 100ml of 70 PCT nitric acid, 94 PCT sulfuric acid and 35 PCT hydrochloric acid, respectively.
         2) After exposure to these fumes for 150 HRS, the finish on the samples shall show no discoloration, disintegration or other effects.
      b. Direct Application Test:
         1) Subject coated samples to the direct action of the following reagents and solvents at a temperature of 25 DEGC dropping from a burette at the rate of 60 drops per minute for ten minutes.
         2) Finish on samples shall not rupture, though slight discoloration or temporary softening is permissible.

Reagent	Concentration
Acetic Acid	98 PCT
Acetone	
Ammonium Hydroxide	28 PCT
Amyl Acetate	
Amyl Alcohol	
Benzene	
Butyl Alcohol	
Calcium Hypochlorite	
Carbon Disulfide	
Carbon Tetrachloride	
Chloroform	

Reagent	Concentration
Chromic Trioxide Acid	
Cresol	
Crude Oil	
Dioxane	
Distilled Water	
Ether	
Ethyl Acetate	
Ethyl Alcohol	
Ethyl Ether	
Formaldehyde	37 PCT
Formic Acid	90 PCT percent
Gasoline	
Glacial Acetic Acid	99.5 PCT
Glycerine	
Hydrochloric Acid	38 PCT
Hydrofluoric Acid	48 PCT
Hydrogen Peroxide	5 PCT
Isopropyl Alcohol	
Lactic Acid	10 PCT
Kerosene	
Methanol	
Methyl Alcohol	
Methyl Ethyl Ketone	
Methylene Chloride	
Mineral Oil	
Monochlor Benzene	
N-Hexane	
Naphthalene	
Nitric Acid	70 PCT
Perchloric Acid	70 PCT percent
Phenol	
Phosphoric Acid	75 PCT
Sea Water	
Silver Nitrate	30 PCT
Sodium Bichromate	saturated
Sodium Carbonate	10 PCT
Sodium Chloride	20 PCT
Sodium Hydroxide	50 PCT
Sodium Hypochlorite	
Sodium Sulfide	
Sulfuric Acid	87 PCT
Toluene	
Trichlorethylene	
Turpentine	
Urea	saturated
Xylene	
Zinc Chloride	saturated

2. Mar and abrasion resistance:
   a. Coating material shall have a pencil hardness of 2H – 4H with adhesion substantial enough to withstand both direct and reverse impacts of 160 IN-LBS.
   b. Coating shall have excellent mar resistance and be capable of withstanding scuffing, marring and other ordinary wear.
3. Reparability:
   a. Scratches and other localized surface damage shall be field-repairable.

2.4 LABORATORY SINKS

A. General:
1. Inside dimensions of sink bowl are provided on drawings.
2. Provide tailpiece compatible with waste piping system for sinks unless otherwise specified.
   a. Refer to Division 22 for piping requirements.

B. Epoxy Resin:
1. Acceptable Manufacturer: Manufacturer shall be the manufacturer of the epoxy resin work surfaces specified in Section 12 35 53.
2. Laboratory Sinks:
   a. Under-mount Type:
      1) Under-mount installation by Division 11 epoxy resin work surfaces.
      2) Color to match work surface.
   b. Comply with the requirements of Section 12 35 53 for epoxy resin.
   c. Exposed edges shall be radiused not less than 1/4 IN.
   d. Tops without drain grooves: Sink shall be set 1/8 IN below the level of the adjacent surface.
   e. Provide epoxy resin sink outlet with strainer, stopper and open-end overflow, and install in sink with continuous bead of silicone sealant.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

A. Inspection:
1. Prior to installation of fixtures, carefully inspect the installed Work specified in other Sections and verify that Work is complete to the point where this installation may properly commence.
2. Verify that Work has been installed in complete accordance with the original design, approved submittals, and the manufacturer's recommendations.

B. Discrepancy:
1. In the event of discrepancy, immediately notify the Architect.

3.2 INSTALLATION

A. General:
1. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.
2. Install fixtures plumb and level.
3. Provide piping connections to fixtures with valves and escutcheons as specified in Division 22.
4. Verify that fixtures and trim are tight, leak-free and function properly

B. Set sinks in chemical resistant sealing compound, secure and support, as recommended by the manufacturer.

END OF SECTION

SECTION 12 35 53
LABORATORY CASEWORK AND OTHER FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Laboratory Casework and Other Furnishings, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SECTION INCLUDES

A. Wood Laboratory Casework

B. Metal Laboratory Casework

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Work in this Section shall be performed by a company having a minimum of eight (8) years documented experience manufacturing the respective products specified herein, and an established organization and production facilities including tools, equipment and special machinery necessary for the fabrication and installation of the type of equipment required, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.
2. Casework manufacturer must have at least one project in past twelve (12) months where the value of the laboratory casework was within 20 PCT of the cost of the laboratory casework for this project.
3. Casework installers shall be approved in writing by the casework manufacturer for the installation of specified products.
4. Work shall be in accordance with the Grade or the Grades specified of the Architectural Woodwork Standards for applicable products.
5. Fabricators of wood, plastic laminate, and solid phenolic casework shall be accredited through the AWI Quality Certification Program (QCP).

B. Undivided Responsibility:
1. Unless specified otherwise, because of special coordination requirements, the supplier of scope of work described in this Section shall also provide scope of work described in following Sections:
2. Section 11 53 43 Laboratory Service Fittings and Fixtures.

C. References:
1. Conform to recommended practices of the Scientific Equipment and Furniture Association (SEFA), current version, except as superseded by this specification:
2. SEFA 2 Installation.
3. SEFA 3 Work Surfaces.
4. SEFA 7 Fixtures.
5. SEFA 8-W Laboratory Grade Wood Casework.
6. SEFA 8-M Laboratory Grade Metal Casework.
7. SEFA 8-PL Laboratory Grade Plastic Laminate Casework.
8. SEFA 8-P Laboratory Grade Polypropylene Casework.

9. SEFA 8-PH Laboratory Grade Phenolic Casework.

D. American Woodwork Institute (AWI), Architectural Woodwork Manufacturers Association of Canada (AWMAC), and Woodwork Institute (WI): Architectural Woodwork Standards (AWS), current edition.
   1. Wood, plastic laminate, and solid phenolic casework shall comply with the AWS, current edition, for grades of casework, construction, finishes, and other requirements.
      a. Provide AWI Quality Certification Program (AWI/QCP) labels indicating that the casework and shelving, including installation, comply with the requirements of grades specified.
      b. This project had been registered as AWI/QCP project number [insert number here].
      c. The Contractor, upon award of work, shall register the work under this Section with the AWI Quality Certification Program (800-449-8811).

E. American National Standards Institute (ANSI):
   1. ANSI A208.1 Particleboard, current edition.
   2. ANSI A208.2 Medium Density Fiberboard (MDF) for Interior Applications, current edition.
   3. ANSI/HVPA HP-1 American National Standard for Hardwood and Decorative Plywood, with the Hardwood Veneer Plywood Association, current edition.
   4. ANSI/BHMA A156.9 Cabinet Hardware Standards, Grade 1.
   5. ANSI/NEMA LD 3 High-Pressure Decorative Laminates.

F. State of California Air Resources Board (CARB):
   1. State of California Air Resources Board "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," CCR Title 17, Sections 93120 – 93120.12

1.4 SUBMITTALS

A. Shop Drawings:
   1. Shop fabrication and installation drawings, including plans, elevations, sections, details and schedules.
   2. Show relationship to adjoining materials and construction.

B. Product Data:
   1. Submit materials list, including catalogue data, of materials, equipment, and products for work in this Section.

C. Project Information:
   1. Structural:
      a. Submit detailed anchorage and attachment drawings and calculations to show compliance with seismic restraint requirements.
      b. Engineering design shall be performed and sealed by registered Engineer, licensed to practice structural engineering in the state of the project location.
      c. Refer to the Structural Drawings for seismic design criteria.
   2. Wood products and painted metal finish:
      a. Provide letter from a third-party testing agency, verifying independent chemical resistance test results.

D. Samples: Accompanying Materials List, submit four (4) samples of each of following items for Architect's approval:
   1. Laboratory Work Surfaces: 4 IN x 4 IN sample of each type specified.

E. Operations/Maintenance Manuals: Accompanying certification, submit for Architect's review and Owner's use, including:
   1. Complete operating and maintenance manuals that describe proper operating procedures.
   2. Maintenance and replacement schedules.
   3. Components parts list.
   4. Nearest factory representative for components and service.

F. Informational Submittals:
1. Statement of Installer Qualifications.
2. Load Tests: Provide on request, load test results certified by an independent testing laboratory for cabinet box, drawers, doors, suspensions slides, and unit shelving as identified in SEFA 8.
3. Certificates:
a. Certify that factory tests specified for mechanical service fixtures have been performed and that products or systems meet or exceed specified requirements.
b. As a condition of acceptance, submit certification stating that equipment is complete and ready for intended function.

1.5 PRODUCT HANDLING

A. Contractor shall schedule the delivery of casework and furnishings when spaces are sufficiently complete so materials can be installed immediately following delivery.

B. Protection: Protect work of this Section before, during and after installation including installed work and materials of other trades.

C. Replacement: Damaged work shall be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

PART 2 - PRODUCTS

2.1 CASEWORK DESIGN AND PERFORMANCE CRITERIA

A. System Structural Performance:
1. Laboratory casework and support framing system shall withstand the effects of the following loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:
a. Casework, doors, drawers, work surfaces and shelving shall be in compliance with SEFA requirements for the respective casework material.
b. Work Surfaces: In addition to SEFA test requirements, work surface spans without continuous base cabinet support shall support 50 LB/SF; deflection shall be limited to 1/180 of the length of the span, not to exceed 1/4 IN.

2.2 WOOD LABORATORY CASEWORK AND TABLES

A. Manufacturers:
1. Refer to Part 1 References and Quality Assurance and Qualifications requirements.

B. Components:
1. California Air Resources Board (CARB) Compliance: Finished goods containing composite wood products in this Section must incorporate a label that clearly identifies compliance with the Airborne Toxic Control Measure (ATCM) Title 17, California Code of Regulations 93120.
2. Wood, Lumber and Veneer:
a. General:
1) Lumber shall be in accordance with the AWS Grade specified for the product being fabricated.
a) Lumber shall be kiln and air dried to a 6 to 8 PCT uniform moisture content, unless specified otherwise.
2) Veneers shall be in accordance with the AWS requirements for its use and the Face Grade with the following modifications.
a) Exposed Plywood Veneer Thickness: 1/45 IN, minimum, unless otherwise noted, and should be of sufficient thickness so as not to permit show-through of cross-banding after sanding or finishing.
b) Exposed Plywood: HPVA Grade A, unless otherwise noted.

c) Semi-Exposed Plywood: HPVA Grade B, unless otherwise noted.
(1) Species: Same species as exposed surfaces.
d) Concealed Plywood: HPVA Grade 1, unless otherwise noted.

b. Wood Species and Veneer Cut: Provide materials that are well matched for color and grain. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
1) Prior to fabrication, veneer panels shall be pre-sorted into consistent color ranges that can be used in common casework elevations. After the color sort, each veneer shall be specifically hand selected by area (within reasonable visual range) for figure, cathedral, and any other natural characteristics present in the faces prior to fabrication of the cabinet faces and exposed portions. The resulting selection shall provide a pleasing uniform color from a single range with natural characteristics, as pre-selected, to not interfere with the overall aesthetic appearance of the casework installation.

c. Hardwood Veneer Plywood Cores:
1) Sink cabinets and panel products within 2 IN of the floor shall be fabricated with moisture resistant substrate.
a) Panel products shall comply with SEFA Base Cabinet Submersion Test.
2) Cabinet Bodies:
a) M3 particle board.
b) Combination Core.
c) Medium Density Fiberboard.
d) M2 particleboard.
3) M3 Particleboard (NAUF: No Added Urea Formaldehyde) with the following attributes:
a) Description: 3-ply, FSC Certified, 100 PCT pre-consumer recycled wood fiber particleboard with no urea formaldehyde added during the manufacturing process.
b) Formaldehyde Emissions: 0.00 to 0.01 ppm.
c) Reference Standards: Average density of 45 to 48 PCF meeting or exceeding ANSI Standard A208.1 M3 PB Standard specifications, current edition.
d) Binder: Urea formaldehyde-free adhesive system.
e) Thickness: 3/4 IN.
f) Moisture Content: less than 8 PCT.
g) Flame spread: ASTM E84 Class 3 or C.
h) Provide MR moisture resistant particleboard at locations identified herein. MR particleboard shall have 50 PCT reduction in thickness swell in accordance with ANSI A208.1
4) Combination Core: NAUF (No Added Urea Formaldehyde), with the following attributes:
a) Description: Composite core plywood panel product for wood veneer consisting of inner veneer plies with medium density fiberboard (MDF) outer crossbands on both sides, combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure, FSC Certified, with no urea formaldehyde added during the manufacturing process.
b) Medium Density Fiberboard (MDF), Grade 155 (NAUF): No Added Urea Formaldehyde) with the following attributes:
(1) Description: Composite panel product consisting of cellulose fibers combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure, FSC Certified, 100 PCT pre-consumer recycled wood fiber with no urea formaldehyde added during the manufacturing process.
(2) California Air Resources Board (CARB 2) Compliance: Composite wood products in this Section must incorporate a label that clearly identifies

compliance with the Airborne Toxic Control Measure (ATCM) Title 17, California Code of Regulations 93120.
(3) Formaldehyde Emissions: as low as 0.01 ppm.
(4) Reference Standards: Meeting or exceeding ANSI Standard A208.2 Grade 155 Standard specifications, current edition.
(5) Binder: Urea formaldehyde-free adhesive system.
(6) Moisture Content: less than 6 PCT.
(7) Flame spread: ASTM E84 Class 3 or C.

c) Formaldehyde Emissions: as low as 0.01 ppm.
d) Binder: Urea formaldehyde-free adhesive system.
e) Physical Properties:
(1) Thickness: 3/4 IN.
(2) Density: 38.4 PCF
(3) Modulus of Rupture: 6010 PSI.
(4) Modulus of Elasticity: 670,894 PSI.
(5) Screw Holding, Face: 274 LBF.
(6) Screw Holding, Edge: 288 LBF.
(7) Moisture Content: less than 8 PCT.
(8) Flame spread: ASTM E84 Class 3 or C.

5) Medium Density Fiberboard (MDF), Grade 155 (NAUF): No Added Urea Formaldehyde) with the following attributes:
a) Description: Composite panel product consisting of cellulose fibers combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure, FSC Certified, 100 PCT pre-consumer recycled wood fiber with no urea formaldehyde added during the manufacturing process.
b) Formaldehyde Emissions: as low as 0.01 ppm.
c) Reference Standards: Meeting or exceeding ANSI Standard A208.2 Grade 155 Standard specifications, current edition.
d) Binder: Urea formaldehyde-free adhesive system.
e) Thickness: 3/4 IN.
f) Moisture Content: less than 6 PCT.
g) Flame spread: ASTM E84 Class 3 or C.
h) Provide MR50 moisture resistant MDF at locations identified herein. MR50 MDF shall have 50 PCT reduction in thickness swell in accordance with ANSI A208.2.

6) M2 Particleboard (NAUF: No Added Urea Formaldehyde) with the following attributes:
a) Description: 3-ply, FSC Certified, 100 PCT pre-consumer recycled wood fiber particleboard with no urea formaldehyde added during the manufacturing process.
b) Formaldehyde Emissions: 0.00 to 0.01 ppm.
c) Reference Standards: Average density of 43 to 45 PCF meeting or exceeding ANSI Standard A208.1 M2 PB Standard specifications, current edition.
d) Binder: Urea formaldehyde-free adhesive system
e) Thickness: 3/4 IN.
f) Moisture Content: less than 8 PCT.
g) Flame spread: ASTM E84 Class 3 or C.
h) Provide MR moisture resistant particleboard at locations identified herein. MR particleboard shall have 50 PCT reduction in thickness swell in accordance with ANSI A208.1
i) 9-ply hardwood plywood manufactured in accordance with ANSI/HVPA HP-1 with K+ face veneers, 1 IN thick.
j) Product shall consist of FSC certified veneers with no urea formaldehyde added during the manufacturing process.
k) Species to match cabinet fronts.

l) Manufactured with non-telegraphing hardwood with exterior glue.

7) Sink cabinets and panel products within 2 IN of the floor shall be fabricated with moisture resistant substrate.

a) Panel products shall comply with SEFA Base Cabinet Submersion Test.

3. Veneer Core Panel for Exposed Edge Finish:
   a. 9 ply panels shall be fabricated from birch veneers with little or no voids for edges to be left for exposed edge finish.
   b. Panels shall be FSC-certified with no urea formaldehyde added during the manufacturing process.
      1) Formaldehyde: DIN 52368 E-1 classification.
      2) Glue: Type II Interior, water-resistant.
   c. Thickness: 1/2 IN for drawer box construction.
      1) Thickness Tolerance: ±0.02 IN.
   d. Characteristics:
      1) Pin knots not permitted.
      2) Other knots and repairs are permitted up to an individual maximum diameter of 6mm provided the cumulative diameter is not greater than 12mm/m2.
      3) Slight irregularities in grain permitted.
      4) Closed splits and checks permitted in length up to 100mm, one per meter of panel width.
      5) Slight discoloration and colored steaks permitted up to an extent of 15 PCT of the surface, with some colored and mineral streaks.
4. Edge band/Facer: 3mm solid hardwood of same material as exposed lumber, except where noted otherwise.
5. Adhesives: Type II water resistant glue.
   a. Adhesives, sealants, and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

C. Design Requirements:
1. Casework Grade:
   a. Base: AWS Premium Grade.
   b. Incorporate identified modified design and fabrication requirements, characteristics, and features as specified.
2. Type A/Frameless, Style 1.

D. Wood Finish:
1. For use on wood casework, wood laboratory tables, wood-framed balance tables, wood-framed pegboards.
2. AWS Premium Grade finish system 10, factory finished.
3. Meet or exceed SEFA 8 W Cabinet Surface Finish requirements.
4. Environmentally friendly, highly chemically resistant, water-based, HAPs (Hazardous Air Pollutants) free, laboratory-grade finish with built-in U.V. blocker and stain.
5. Solvent applied coatings are not acceptable.
6. Offgasing:
   a. Finish shall be firm and stable after final cure.
   b. No further emissions or offgassing/decomposition vapors shall occur at room temperature.
7. Flat line finish system, spray or roll coat.

2.3 PLASTIC LAMINATE LABORATORY CASEWORK

A. Manufacturers:
1. Refer to Part 1 References and Quality Assurance and Qualifications requirements.

B. Components:
1. California Air Resources Board (CARB) Compliance: Finished goods containing composite wood products in this Section must incorporate a label that clearly identifies

compliance with the Airborne Toxic Control Measure (ATCM) Title 17, California Code of Regulations 93120.

2. Decorative (Plastic) Laminate:
   a. Laminate shall be in accordance with the AWS Grade specified for the product being fabricated with the following modifications.
      1) Sink Cabinet Interior Bottom: Horizontal, Laboratory Grade, chemical resistant decorative laminate, Wilsonart® Chemsurf (no known equal).
      2) Decorative laminates shall contain a minimum weighted average of 20 PCT post-industrial recycled content.
      3) Laminate shall be GREENGUARD Indoor Air Quality Certified®.
   b. Core Material:
      1) Sink cabinets and panel products within 2 IN of the floor shall be fabricated with moisture resistant substrate.
         a) Panel products shall comply with SEFA Base Cabinet Submersion Test.
      2) M3 Particleboard (NAUF):
         a) 3-ply, FSC Certified, 100 PCT pre-consumer recycled wood fiber particleboard.
         b) Formaldehyde Emissions:
            (1) 0.00 to 0.01 ppm.
         c) Average density of 45 to 48 PCF, meeting or exceeding ANSI Standard A208.1 M3 PB Standard specifications, current edition.
         d) Thickness:
            (1) 3/4 IN.
         e) Moisture Content:
            (1) Less than 8 PCT.
         f) Flame spread:
            (1) ASTM E84 Class 3 or C.
         g) Provide MR moisture resistant particleboard at locations identified herein. MR particleboard shall have 50 PCT reduction in thickness swell in accordance with ANSI A208.1
      3) Combination Core (NAUF):
         a) Composite core plywood panel product for laminated plastic consisting of center veneer layered with two alternating crossband veneers on both sides, with outer layers of medium density fiberboard (MDF), combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure, FSC Certified, with no urea formaldehyde added during the manufacturing process.
         b) Medium Density Fiberboard (MDF), Grade 155 (NAUF):
            (1) Composite panel product consisting of cellulose fibers combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure, FSC Certified, 100 PCT pre-consumer recycled wood fiber with no urea formaldehyde added during manufacturing process.
            (2) California Air Resources Board (CARB 2) Compliance: Composite wood products in this Section must incorporate a label that clearly identifies compliance with the Airborne Toxic Control Measure (ATCM) Title 17, California Code of Regulations 93120.
            (3) Formaldehyde Emissions: As low as 0.01 ppm.
            (4) Reference Standards: Meeting or exceeding ANSI Standard A208.2 Grade 155 Standard specifications, current edition.
            (5) Binder: Urea formaldehyde-free adhesive system.
            (6) Moisture Content: Less than 6 PCT.
            (7) Flame spread: ASTM E84 Class 3 or C.
         c) Formaldehyde Emissions: as low as 0.01 ppm.
         d) Binder: Urea formaldehyde-free adhesive system.

e) Physical Properties:
(1) Thickness: 3/4 IN.
(2) Density: 38.4 PCF
(3) Modulus of Rupture: 6010 PSI.
(4) Modulus of Elasticity: 670,894 PSI.
(5) Screw Holding, Face: 274 LBF.
(6) Screw Holding, Edge: 288 LBF.
(7) Moisture Content: less than 8 PCT.
(8) Flame spread: ASTM E84 Class 3 or C.

4) M2 Particleboard (NAUF: No Added Urea formaldehyde) with the following attributes:
a) Description: 3-ply, FSC Certified, 100 PCT pre-consumer recycled wood fiber particleboard with no urea formaldehyde added during the manufacturing process.
b) Formaldehyde Emissions: 0.00 to 0.01 ppm.
c) Reference Standards: Average density of 43 to 45 PCF meeting or exceeding ANSI Standard A208.1 M2 PB Standard specifications, current edition.
d) Binder: Urea formaldehyde-free adhesive system.
e) Thickness: 3/4 IN.
f) Moisture Content: less than 8 PCT.
g) Flame spread: ASTM E84 Class 3 or C.
h) Provide MR moisture resistant particleboard at locations identified herein. MR particleboard shall have 50 PCT reduction in thickness swell in accordance with ANSI A208.1

5) Veneer Core Hardwood Panel for Shelves and Toe Kicks:
a) 9-ply hardwood plywood manufactured in accordance with ANSI/HVPA HP-1 with K+ face veneers, 1 IN thick.
b) Product shall consist of FSC certified veneers with no urea formaldehyde added during the manufacturing process.

6) Sink cabinets and panel products within 2 IN of the floor shall be fabricated with moisture resistant substrate.
a) Panel products shall comply with SEFA Base Cabinet Submersion Test.

3. Edge Banding:
a. Doors, drawer fronts and cabinet edges: 3mm PVC, profiled to 1/8 IN radius. T-Mold is not acceptable.
b. Exposed other cabinet body edges: 1mm PVC.
c. Machine applied with hot melt adhesive.

4. Adhesive:
a. Type II water resistant glue.
b. Adhesives, sealants, and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
c. Polyvinyl acetate or thermosetting laminate adhesive applied in accordance with NEMA LD 3.1.
1) Laminate adhesive shall be GREENGUARD Indoor Air Quality Certified®.

C. Design Requirements:
1. Casework grade:
a. Base: AWS Premium Grade.
b. Modifications: In addition to satisfying the specified grade, products shall incorporate the identified modified design and fabrication requirements, characteristics, and features as specified herein.
2. Construction type: Type A/Frameless, Style 1.

3. Exposed, semi-exposed, and concealed surfaces shall be as defined in the AWS with the following modifications:
   a. Following shall be treated as exposed surfaces:
      1) Exterior surfaces of suspended and mobile casework.
      2) Sides of tall cabinets.

D. Fabrication:
1. Cabinets Ends/Sides:
   a. Edge band top edge of wall/upper cabinets when visible from above.
   b. Aprons assemblies: Not greater than 4-5/16 IN high.
   c. Edge band bottom of side and end panels.
   d. Finished Side Panels: Each unit shall be complete, with finished, edge banded side panels, so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts. Fabricate side panels as exposed surfaces.

2.4 LABORATORY WORK SURFACES

A. Epoxy Resin:
1. Countertop Grade: AWS Premium Grade.
   a. Modifications: In addition to satisfying the specified grade, products shall incorporate the identified modified requirements, characteristics, and features as specified herein.
2. Manufacturers:
   a. Durcon Inc.
   b. Epoxyn Products.
   c. Kewaunee Scientific Corporation.
   d. Other manufacturers desiring approval comply with Section 01630.
   e. Substitutions are not permitted.
3. Thickness:
   a. Typical work surface: 1 IN.
4. Color:
   a. Black.
5. Provide the following:
   a. Drip Grooves:
      1) Provide under work surface exposed edges, unless noted otherwise on the Laboratory Furnishing Drawings.
      2) Where the top overhangs 1 IN: 1/2 IN from the edge.
   b. Edge profile:
      1) All exposed upper edges and corners: 1/4 IN radius, or 1/8 IN bevel.
   c. Indented areas:
      1) Where indicated on the Laboratory Furnishing Drawings.
      2) Profile: 1/4 IN deep with chamfered or radiused sides.
      3) Internal and external corners: 1/4 IN to 1/2 IN radius.
      4) Marine edges formed around indented areas shall not be less than 1 IN wide.
   d. Sink Mounting:
      1) Under-mounted Sink Cutouts:
         a) Smooth and uniform without saw marks.
         b) Uniform radius of approximately 1/8 IN on the top edge conforming to the sink shape.
         c) The bottom edge of sink openings shall be finished smooth.
         d) Supported by brackets mounted to the sides of the base cabinet below the sink.
   e. Curbs and Splashes:
      1) Curbs and Splashes: 3/4 IN thick.
      2) Height: 4 IN, unless noted otherwise on Laboratory Furnishing Drawings.
      3) Bonded to the surface of the top to form a square joint.

f. Provide holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form inside corners to a radius of not less than 1/8 IN. After sawing, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a waterproofing material recommended by the manufacturer.

6. Physical Properties:
   a. Chemical resistance:
      1) Organic solvents test:
         a) Saturate a cotton ball with the test chemical; place; in a one ounce bottle with a reservoir of liquid above the ball.
         b) Invert the container on the test material surface for a period of 24 HRS.
         c) Test temperature: 23 DEGC ±2 DEGC.
      2) Other test chemicals test:
         a) Place five drops (1/4 cc) of the test chemical on the test material surface.
         b) Cover the chemical with a 25mm diameter watch glass for a period of 24 HRS.
         c) Test temperature: 23 DEGC ±2 DEGC.
      3) Evaluation:
         a) After 24 HRS exposure: Wash exposed areas with water, then with a detergent solution, finally with naphtha, then rinse with distilled water, dry with a cloth, and rate as follows:

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernible change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
4	Failure	Pitting, cratering, or erosion of the surface. Obvious and significant deterioration.

      4) Test results:

Test chemical	**Concentration** Percent	**Black**	**Dark gray**	**Light gray**	**Beige**
Chromic acid	40	3	2	2	2
Hydrochloric acid	10	0	0	0	0
Hydrochloric acid (conc.)	37	0	0	0	0
Nitric acid	40	0	0	0	0
Nitric acid (conc.)	70	0	0	0	0
Sulfuric acid	60	0	0	0	0
Sulfuric acid (conc.)	96	4	4	4	4
Acetic acid	5	0	0	0	0
Acetic acid (glacial)		0	0	0	0
Citric acid	1	0	0	0	0
Oleic acid		0	0	0	0
Phenol solution	5	0	0	0	0
Ammonium hydroxide	10	0	0	0	0
Sodium carbonate sol.	20	0	0	0	0
Sodium hydroxide sol.	60	0	0	0	0

Test chemical	Concentration Percent	Black	Dark gray	Light gray	Beige
Sodium hypochlorite sol.	4	0	0	0	0
Acetone		1	1	1	1
Benzene		1	1	1	1
Carbon tetrachloride		1	1	0	0
Diethyl ether		0	0	1	1
Dimethyl formamide		0	0	0	0
Ethyl acetate		0	1	1	0
Ethyl alcohol	95	0	0	0	0
Ethylene dichloride		0	0	0	0
Heptane		0	0	1	0
Isooctane		0	0	0	0
Kerosene		0	0	0	0
Methyl alcohol		0	0	0	0
Toluene		0	0	0	0
Aniline		0	0	0	0
Mineral oil		0	0	0	0
Olive oil		0	0	0	0
Soap solution	1	0	0	0	0
Transformer oil		0	0	0	0
Turpentine		0	0	0	0

b. Heat resistance tests:
   1) High temperature test:
      a) Heat a porcelain crucible to a dull red color, place on the test material, and allow to cool to ambient temperature.
      b) Result: No observable surface deformation.
   2) Flame test:
      a) Overturn a 3/8 IN Bunsen burner, adjusted to a quiet flame, with a 1-1/2 IN inner cone, on the test material, and allow to stay for 5 minutes.
      b) Result: no observable surface deformation.

c. Physical properties:

Physical Properties		
Compressive strength	ASTM D695	216mPa 31,400 PSI
Tensile strength	ASTM D638	55mPa 8,000 PSI
Flexural strength	ASTM D790	81mPa 11,700 PSI
Rockwell hardness M	ASTM D785	122
Specific density	ASTM D792	1960kg/m2 122.4 PSF
Water absorption	ASTM D570	0.01 PCT
Fire Resistance	ASTM D635	ATB (sec)=0
Heat deflection at 264 PSI (1.82 MPa)	ASTM D648	172 DEGC 342 DEGF

2.5 WALL HUNG BENCHTOP

A. Framing Channel, Fittings, and End Caps: Stainless steel slotted channel framing as specified elsewhere on this Section and as indicated on the drawings.

B. Benchtop material shall be as indicated on the drawings and as specified elsewhere in this Section.
   1. Benchtops shall be completely wall supported with no legs or support members extending to the floor.
   2. Coordinate with wall or partition framing for blocking.

C. Unit shall be designed to support the structural load performance criteria in Part 1 of this Section,

2.6 DRYING RACK

A. Epoxy Drying Rack:
   1. Comply with requirements for molded epoxy resin specified under Laboratory Tops in this Section and as described herein.
   2. Drying rack bodies shall be of 1 IN thick black epoxy with a 3/16 IN to 1/4 IN radius on edges and corners. Each rack shall be of the size and with the peg arrangement shown on the Laboratory Furnishing drawings.
   3. Pegs shall be of injection molded black polypropylene. Pegs shall not be bonded into the body, but shall be held in position by mechanical design.
   4. Provide a drip trough of Type 304 stainless steel with a 16 GA, Type 304 stainless steel screen of 14 x 14 mesh, 0.02 IN wire. Drip trough shall be continuously welded.
   5. Provide stainless steel fixing screws of appropriate type for attachment to support structure.
   6. Provide clear, tight-fitting hose to drain from drip tray into sink.

2.7 SEALANT

A. Refer to Section 07 92 16.

B. Sealant shall be installed by installer of the work of this Section.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

A. Inspection:
   1. Prior to installation of the work of this Section, verify installed work is complete to the point where this installation may properly commence.
   2. Verify that work may be installed in complete accordance with the original design, reviewed submittals, and the manufacturer's recommendations.
   3. Verify adequacy and proper location of any required backing or support framing.
   4. Verify that mechanical, electrical, plumbing and other building components affecting work in this Section are in place and ready.

B. Project Conditions: Casework and furnishings shall not be delivered and installed prior to completion of the followings items:
   1. Finished ceilings, if specified, overhead ductwork, piping, electrical, and lighting work shall be installed.
   2. Painting shall be complete.
   3. Flooring shall be installed, except when an integral base as specified to be installed over the casework toe kick.
   4. Interior building temperature shall be maintained between 65 DEGF and 80 DEGF, and ambient relative humidity shall be maintained between 25 PCT and 55 PCT prior to delivery, and during and after installation. Frequent and/or excessive changes in temperature and/or humidity levels during casework installation, or once casework is installed, must be avoided to prevent damage to materials.

C. Delivery:
   1. Product shall be stored in a clean storage area.

2. Delivery of laboratory casework shall be made only when the area of operation is enclosed, plaster and concrete work is dry, and the area broom clean.

D. Discrepancy: In the event of discrepancy, immediately notify the Architect.

3.2 INSTALLATION

A. Installation of items specified in this Section shall be performed by installers experienced in the installation of the respective item as determined by the respective manufacturer.

B. Coordinate work with any Owner furnished and/or installed components indicated on drawings.

C. Casework:
1. Set casework items square, plumb, and level. Shim as required, using concealed shims and securely anchor.
2. Where required, assemble units into one integral unit with joints flush, tight, and uniform.
3. Provide matching filler pieces where casework abuts walls or columns, or should be closed off.
   a. All wood, plastic laminate, solid phenolic and polypropylene work abutting other building components shall be properly scribed.
4. Mechanical fasteners used at exposed and semi-exposed surfaces, excluding installation attachment screws and those securing cabinets end to end, shall be countersunk.
5. Cutouts for equipment, mechanical, electrical or plumbing services shall be made by the casework manufacturer or casework installer.

D. Laboratory Tops:
1. Scribe tops as necessary for close and accurate fit.
2. Field Joints: Factory-prepared and identical to factory joints, locate only where indicated on approved Shop Drawings. Field processing of top and edge surfaces is not acceptable, except as described by manufacturer in approved Submittal Data. Provide full length, one-piece tops and backsplashes wherever possible, and keep field joints to an absolute minimum.
3. Abut top and edge surface in one true plane, with internal supports placed to prevent any deflection. Joints in top units shall be flush and the narrowest for the respective materials of construction.
4. Epoxy Resin: Cement joint in accordance with the manufacturers' specifications.

E. Tolerances: Casework shall not exceed the following tolerances:
1. Variation of Adjacent Surfaces from a True Plane: 1/32 IN.
2. Variation of Work Surfaces from Level: 1/16 IN in 10 FT.

F. Laboratory Sinks:
1. Epoxy Resin, Undermount: Sinks shall be set in work surface with chemical-resisting sealing compound, secured and supported in accordance with manufacturer's instructions. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

G. Miscellaneous Furnishings and Accessories:
1. Install in accordance with manufacturer's instructions.
2. Securely fasten wall mounted adjustable shelving supports, stainless steel shelves, drying racks, etc. to partition framing, wood blocking, or reinforcements in partitions.
3. Tighten screws to seal flat; do not drive.

H. Sealant:
1. Caulk edges of tops, backsplashes and side splashes to adjacent wall surface, and around work surface penetrations, with sealant.
2. Sealant application shall be in accordance with manufacturer's published recommendations.

I. Repair or remove and replace defective work as approved by the Architect at no additional cost to the Owner.
   1. Where approved by Architect, touch-up finishes applied to damaged surfaces shall have a VOC content of no more than 250 g/L in accord with SCAQMD Rule #1168.

3.3 CLEANING

A. Clean finished units, remove any pencil and ink marks, touch up as required, and remove and refinish damaged or soiled areas.

B. Clean counter tops with diluted dishwashing liquid and water leaving tops free of grease and streaks. Use no wax or oils.

C. Before completion of installation, the installer shall adjust moving and operating parts to function smoothly and correctly.

D. Nicks, chips, and scratches in the finish shall be filled and retouched. Damaged items that cannot be repaired shall be replaced.

3.4 PROTECTION

A. Cover work surfaces with 1/4 IN corrugated cardboard, secured in place, after installation for protection against scratching, soiling, and deterioration during remainder of construction period. Remove protection prior to final cleaning.

B. Standing or staging work on protected or unprotected work surfaces is not allowed.

END OF SECTION

SECTION 12 36 63
SOLID SURFACE FABRICATIONS (SSF)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Solid Surface Fabrications, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Applicable standards:
   1. International Association of Plumbing and Mechanical Officials (IAPMO)
      a. IAPMO Z124 Plastic Plumbing Fixtures.
   2. ASTM International:
   3. National Electrical Manufacturers Association (NEMA).
      a. NSF International.
         1) NSF/ANSI Standard 51 for food zone - all food types.
   4. Manufacturer's certification of fabricator and installer.

B. Installer Qualifications:
   1. Successfully installed at least five projects within the past four years, utilizing systems, materials and techniques as specified or required by product manufacturer.

C. Manufacturer Certification of Fabricator and Installer:
   1. Certified by manufacturer.
   2. Submit prior to Shop Drawings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Show location of each item, dimensioned plans and elevations, large scale details, attachment devices and other components.
   2. Show full size details, edge details, thermoforming requirements, attachments, etc.
   3. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement.
   4. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in surface.
   5. Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.

B. Product Data:
   1. Manufacturer's product data sheets, details and installation instructions for Solid Surface Fabrications, components and accessories.

C. Samples:
   1. For each SSF color selected:
      a. Minimum 6 IN x 6 IN sample in specified gloss.
      b. Cut sample and seam together for representation of inconspicuous seam.
      c. Indicate full range of color and pattern variation.
   2. Sealant colors for selection.
   3. Approved samples will be retained as a standard for work.

D. Project Information:
   1. Manufacturer's current certification of Fabricator and Installer prior to submittal of Shop Drawings.

E. Contract Closeout Information:
   1. Warranty.
   2. Maintenance data.
      a. See Section 01 77 00.

1.4 WARRANTY

A. Manufacturer's ten (10) year warranty including colorfastness and material defects.
   1. Warranty shall provide material and labor to repair or replace defective materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Solid Surface Fabrications (SSF):
   1. Base:
      a. Corian by DuPont.
   2. Optional:
      a. Avonite by Aristech Acrylics LLC.
      b. Hi-Macs by LG Decorative Surfaces.
      c. Wilsonart Solid Surface.

B. Sealant:
   1. Base:
      a. Color Rite.
   2. Optional:
      a. As approved by SSF manufacturer.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Solid Surface Materials:
   1. Cast, non-porous, homogeneous, acrylic polymer composition with additional fire retardant fillers and pigments.
      a. Prime product may not be coated, laminated or of composite construction.
   2. Defects with depth < 0.010 IN shall be considered superficial.
      a. Repair superficial damage by sanding and/or polishing.
      b. Components with more severe defects shall be rejected.
   3. Physical properties:

Minimum Physical Properties		
Property	Method	Value
Tensile Strength	ASTM D638	5500 PSI
Flexural Strength	ASTM D790	10 KSI
Hardness	Rockwell M Scale ASTM D785	Greater than 85
	Barcol Impressor ASTM D2583	55
Thermal Expansion	ASTM D696	1.8 x 10-5 IN/IN/DegF
Gloss (60 –degree Gardner)	IAPMO Z124	Matte = 5; Highly Polished = 75
Light Resistance	NEMA LD 3-2000 Method 3.3	No Effect (Xenon Arc)
Wear and Cleanability	IAPMO Z124	Pass

Stain Resistance	IAPMO Z124	Pass
Fungal Resistance	ASTM G21	Does not support growth
High Temperature Resistance	NEMA LD 3-2000 Method 3.6	No change
Boiling Water Resistance	NEMA LD 3-2000 Method 3.5	No visible change
Ball Impact Resistance; 1/2 LBS Ball	NEMA LD 3-2000 Method 3.5	36 IN drop 1/4 IN sheet
		144 IN drop 1/2 IN sheet
Water Absorption	ASTM D570	0.8 PCT for 1/4 IN sheet
		0.6 PCT for 1/2 IN sheet
Flammability	ASTM E84 and NFPA 255	Class I / Class A
Flame Spread Index		Less than 25
Smoked Developed Index		Less than 450

B. Backing materials (build down):
   1. Finished or exposed edges: SSF material.
      a. Profiles as indicated.
   2. Concealed spaces and non-exposed edges:
      a. Moisture resistant, medium density fiberboard (MDF) panels or moisture resistant plywood.
         1) Use at countertops with sinks
         2) No added formaldehyde (NAF)
         3) Particleboard is not acceptable.
         4) Base Product: Medex by Roseburg.
      b. Physical Properties, Based on 3/4 IN Thickness, ASTM D1037, Part A:
         1) Density: 48 LBS/FT3.
         2) Modulus of Rupture: 4,000 PSI.
         3) Screw Holding: Required to pull 1 IN #10 sheet metal screw:
            a) Face: 225 LBS.
            b) Edge: 200 LBS.
      c. Panel Thickness:
         1) As required for application, use a single thickness to achieve build down to cross sectional thickness.
   3. Backer Sheets for knee spaces:
      a. Plastic laminate in coordinating color
      b. Grade 20 (VGP)
      c. Apply to bottom side of backing material
   4. Backing materials adhesive:
      a. Construction grade adhesive recommended by SSF manufacturer for backing materials with VOC content no greater than 70 g/L.

C. Joint Adhesive:
   1. Manufacturer's standard one- or two-part adhesive as required for inconspicuous, non-porous joint with VOC content no greater than 80 g/L.

D. Sealant:
   1. Mildew resistant silicone sealant in colors matching components.
   2. Specifically formulated for applications indicated, including wet areas.
   3. Shore A Hardness: 25.
   4. Compatible with SSF specified.
   5. Compatible with gypsum wallboard, paint, laminates and other materials being sealed.
   6. Sealant VOC content shall be no greater than 250g/L.
   7. Colors:
      a. Colors to match specified SSF colors from no less than 400 standard color choices.
      b. Number of different colors required for project shall not be limited.

8. Base Products:
   a. At solid colored SSF: Color-Sil by Color Rite; 100 PCT silicone.
   b. Where speckle colored SSF is specified: Poly-Sil by Color Rite; 100 PCT silicone with suspended accent color particles.
   c. Architect to select final colors and locations during submittals phase.

E. Conductive Foil Tape:
   1. Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.

F. Insulating Felt Tape:
   1. Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.

2.3 SHOP FABRICATION

A. Shop Assembly
   1. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's instructions.
   2. Form joints between components using color matched Joint Adhesive in an inconspicuous manner.
      a. Reinforce with 4 IN wide strip of SSF material.
   3. Provide factory cutouts for plumbing fittings and bath accessories as indicated.
      a. Radius inside corners of cutouts as large as but not less than 1/4 IN.
      b. Reinforce with SSF corner blocks to avoid stress cracking.
      c. Sand edges and corners smooth and free of chips or nicks.
      d. Utilize heat conductive aluminum tape around drop-in stoves and other heat sources to protect SSF from thermal stress.
   4. Rout and finish component edges with clean, sharp returns.
      a. Rout cutouts, radii and contours to template.
      b. Smooth edges.
      c. Repair or reject defective and inaccurate work.
   5. Fabricate coved splashes where indicated.
   6. Reinforce inside corners, narrow pieces, cantilevered overhangs, and stress points against breakage by laminating an additional thickness of SSF on concealed face.
   7. Laminate additional thicknesses of SSF and tool edge profiles indicated.
   8. Uniformly finish completed pieces according to SSF schedule.

2.4 FABRICATIONS

A. SSF Window Sills:
   1. Configurations detailed on Architectural Drawings.
   2. Thickness: Minimum 1/2 IN (unless otherwise indicated).
   3. Join multiple pieces with joint adhesive to create inconspicuous seam.
   4. Edge Treatments: As indicated on the drawings.
   5. Polish exposed faces.
   6. SSF Color / Pattern / Finish: Per SSF Schedule.

B. SSF Wall Caps, Niches and Similar Decorative Uses:
   1. Configurations detailed on Architectural Drawings.
   2. Thickness: Minimum 1/2 IN, unless otherwise indicated.
   3. Join multiple pieces with joint adhesive to create inconspicuous seam.
   4. Edge treatments: As indicated on the drawings.
   5. Polish exposed faces.
   6. SSF color / pattern / finish: Per SSF Schedule.

C. SSF Countertops:
   1. Configurations as indicated on the IC-series Drawings.

2. Composite thickness of countertop assemblies: 1-1/4 IN unless otherwise indicated.
   a. Nominal Thickness of SSF material: Minimum 1/2 IN unless otherwise indicated.
3. Radius exposed outside corners: Minimum 1-1/2 IN.
4. Join multiple pieces, where required, with Joint Adhesive to create inconspicuous seam.
5. Backer:
   a. Configure backing material as required for application:
   b. Ladder frame at SSF countertops supported by base cabinets:
      1) Form ladders from approved backing material ripped into 3- 4 IN wide strips.
      2) Locate main runner strips (rails) along front and back edges of countertops.
         a) Provide clearance for shrinkage and normal expansion and contraction.
      3) Space front-to-back supports (stiles) to align with line where base cabinet units adjoin. Locate stiles over other wall brackets and supports.
      4) Where base cabinets and supports exceed in 24 IN width: Include additional intermediate stiles so that maximum spacing does not exceed 24 IN.
      5) Provide additional intermediate stiles at seams in SSF countertop material.
      6) Join the stiles to rails using screwed or glued wooden biscuit seams, serrated dowels or rabbeted seams.
      7) Overhangs: Configure backer material per SSF manufacturer's guidelines according to distance overhang projects past its support.
   c. Countertops which span between supports 30 IN and wider:
      1) Fabricate backer from solid backing material (not stile and rail construction).
      2) Extend one piece, solid backer material, across entire span. Extend load bearing edges not less than 4 IN over edge of supporting cabinets (or similar support).
   d. Portions of Countertops schedule to support countertop equipment:
      1) Provide full backing for the entire countertop cross section for the full width of the equipment.
      2) Extend 4 IN (min) beyond equipment width and as required for mounting.
6. Backsplashes and Sidesplashes:
   a. Provide where indicated.
   b. Thickness: Minimum 1/2 IN (unless otherwise indicated).
   c. Height: As indicated.
   d. Fabricate from same material and color as top.
   e. Backsplash Style: Integrally coved.
   f. Sidesplash Style: Applied.
7. Front overhang of Tops: 1-1/2 IN, unless otherwise indicated.
8. Edge Treatments: As indicated on the drawings.
9. Polish exposed faces.
10. SSF color / pattern / finish: Per SSF Schedule.

D. Integral SSF Sinks:
   1. Material: Cast, homogenous material composed of polyester and acrylic resins, fire retardant filler materials, and coloring agents.
   2. Shapes complying with IAPMO Z124 standards for plastic sinks and lavatories.
   3. Mounting: Seamed under mount.
   4. Mounting hardware: Manufacturer's standard bowl clips, panel inserts and fasteners for attachment of undermount sinks/lavatories.
   5. Provide bowl size and depth as indicated on IC-series elevations.
   6. Base Product: Model # 810.
   7. Color: Cameo White.

E. Sinks specified elsewhere:
   1. Porcelain, enameled steel and/or stainless steel bowls: Specified in Section 22 42 00.

F. Faucets and Trim: Specified in Section 22 42 00.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with fabricator present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. Verify measurements, dimensions and drawing details before proceeding.
   2. Coordinate location of furring, nailers, blocking, grounds and similar supports for attached work.
   3. Examine conditions under which work is to be installed.
   4. Correct unsatisfactory conditions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. General:
   1. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
   2. Provide product in the largest pieces available.
   3. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
      a. Exposed joints/seams will not be allowed.
   4. Reinforce field joints with SSF strips extending a minimum of 1 to 2 IN on either side of the seam with the strip being the same thickness as the top.
   5. Cut and finish component edges with clean, sharp returns.
   6. Rout radii and contours to template.
   7. Anchor securely to base cabinets or other supports.
   8. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
   9. Carefully dress joints smooth, remove surface scratches and clean entire surface.
   10. Install countertops with no more than 1/8 IN sag, bow or other variation from a straight line.
   11. Units with sinks or lavatories shall withstand an applied vertical load of not less than 250 LBS on front edge of countertop.

B. Window Stools (sills):
   1. Shim as required so that installed items are plumb, true and level.
   2. Install Window Sills full length of window, set securely into place using only concealed fasteners and approved adhesive.
   3. Adhere sills to substrate with dabs of a clear silicone sealant at 10 to 12 IN intervals.
   4. Where sills are abutted by walls at both ends: Allow 1/8 IN expansion gaps at both ends for every of 10 FT sill.
      a. Seal gaps with elastomeric sealant.
   5. Ease edges and sand smooth.

C. Countertops:
   1. Install plumb, level, true and straight.
      a. Shim as necessary using concealed shims.
   2. Adhere tops to base cabinets with clear silicone sealant at 10 to 12 IN apart.
   3. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
      a. Supply additional wood supports, spaced no more than 18 IN apart or as otherwise required for adequate strength.
   4. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
      a. Ensure full contact with support brackets and backing for entire support length with mechanical fastening into backing material.

b. Provide fasteners of appropriate length. Do not allow screws to penetrate into SSF material.
c. Supply additional supports or solid backing as required for adequate strength.

5. Where tops are abutted by walls at both ends:
   a. Include 1/8 IN expansion gaps at both ends for every of 10 FT countertop.
   b. Seal gaps with elastomeric sealant.

D. Backsplashes and Sidesplashes:
1. Integrally Coved Splashes:
   a. Join coved items to countertops using color matched Joint Adhesive.
   b. Adhere to walls and other substrates with clear silicone sealant.
   c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.
2. Applied Splashes:
   a. Join adhered items to substrate using color matched, elastomeric sealant.
   b. Adhere to walls and other substrates with clear silicone sealant.
   c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.

E. Integral SSF Sinks:
1. Install SSF sink or lavatory bowls in locations shown on the drawings.
2. Secure bowls to tops using Joint Adhesive and mounting hardware to maintain warranty.
3. Drain connections: Specified in Section 22 42 00.

F. Sinks:
1. Install sinks per Section 22 42 00.
2. Seal to Countertop with elastomeric sealant and mounting hardware provided.
3. Drain and overflow connections: Specified in Section 22 42 00.

G. Faucets and Trim:
1. Install faucets and trim per Section 22 42 00.
2. Plumbing connections: Specified in Section 22 42 00.
3. Seal to Countertop with elastomeric sealant.

3.3 CLEANING AND PROTECTION

A. Keep components clean during installation.

B. Protect finished surfaces from damage.

C. Remove adhesives, sealants and other stains.

D. Replace damaged work which cannot be repaired.

END OF SECTION

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SECTION 13 48 00
ARCHITECTURAL SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Seismic Restraint Systems in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Company specializing in manufacture of Architectural Seismic Restraint Systems with ten (10) years minimum successful, documented experience.

B. Erector Qualifications:
   1. Company experienced in erecting Architectural Seismic Restraint Systems and certified by system manufacturer.

C. Description of Systems:
   1. Transverse and longitudinal bracing for seismic forces on suspended systems including ceilings and equipment.
   2. Anchorage of floor mounted equipment, casework and partitions.
   3. Provide bracing and anchoring for equipment and components designed, constructed, and installed to resist stresses produced by lateral forces specified in section 01 41 40 Wind and Seismic Design Criteria.
   4. Design and install seismic anchorage and bracing for floor mounted equipment and components weighing 400 LBS or more.
   5. Design and install seismic anchorage and bracing for overhead suspended equipment and wall mounted equipment and components weighing 20 LBS or more

D. Provide Architectural Seismic Restraint Systems engineered to support dead, live, and lateral, wind or seismic, loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. For each type of material and accessory.

C. Shop Drawings:
   1. Layout and mounting detail drawings showing system and proposed brace locations for systems including pre-engineered systems.
   2. Reference specific detail for each type of brace or anchor identifying required locations.

D. Project Information:
   1. Structural calculations for Architectural Seismic Restraint Systems indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Architectural Seismic Restraint Systems:
   1. Base:
      a. Mason Industries
   2. Optional:
      a. Amber/Booth Company
      b. Vibro-Acoustics

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Equipment Anchors and Supports:
   1. Structural steel for supports:
      a. ASTM A36.
   2. Cold formed metal and connection material:
      a. Slotted Channel Framing by Hilti.
   3. Drilled-in-place concrete anchors:
      a. Provide approved ICC Evaluation Services Report.
   4. Cast-in-place anchors:
      a. Comply with ASTM A36, ASTM A307, or ASTM F1554-36.
   5. Anchors permanently exposed to weather or corrosive environments:
      a. Stainless steel or hot-dipped galvanized.

PART 3 - EXECUTION

3.1 GENERAL

A. Design and install bracing and anchoring for equipment, partitions, ceilings, casework and other architectural components in accordance with requirements of this section.

B. Suspended component having a minimum 5 FT straight length shall have a minimum of two transverse braces and one longitudinal brace.
   1. Bracing may be omitted from component runs less than 5 FT in length.

C. Brace spacing shall not exceed maximum allowable brace spacing as engineered by manufacturer or custom bracing designer.
   1. Provide bracing on runs where rod hung supports are required to be greater than 12 IN in length.Rod hung supports less than12 INshall not create moment forces on hanger rod.

D. Transverse brace may act as a longitudinal brace if brace arm and anchorage have been sized to meet or exceed requirements of longitudinal brace.

E. When bracing equipment or utility system suspended from overhead deck, brace to overhead deck or to structure supporting deck.
   1. Do not brace to another element of structure which may respond differently during seismic event.

F. Obtain approval from Structural Engineer prior to installation of brace elements to structural steel framing.

G. Tension cable to remove slack from cable bracing without inducing uplift of suspended element.
   1. Tension seismic bracing system prior to equipment start up and adjust after start up.

H. Do not mix rigid bracing with cable bracing in same run unless approved by Structural Engineer.

I. Install brace members at an angle of 45 DEG from horizontal within a tolerance of plus 2 1/2 DEG or minus 45 DEG provided brace length is included in design.

1. Increase brace angle to 60 DEG and reduce brace spacing to one-half that required for 45 degree brace.

J. Seismic bracing shall not pass through a building separation joint.

K. Systems passing through separation joint must be seismically restrained within 5 FT of point of connection or any hardware designed to accommodate seismic movement across span of separation joint.

L. With approval of Structural Engineer, systems within basement suspended from overhead deck may be braced to load bearing basement walls, provided walls and overhead decks respond similarly during a seismic event.

M. Brace each layer of multiple layer trapeze rack individually based on weight of individual layer.

N. Through-bolted Elements:
1. Mounting hole in element shall be no more than 1/16 IN diameter larger than bolt or threaded rod.

O. Seismic braces shall directly brace system and not hanger.

3.2 FLOOR MOUNTED EQUIPMENT

A. Provide one mounting device on each leg or support with minimum three (3) 3/8 IN diameter anchors.
1. Do not include friction when designing anchors for shear.

B. Seismic forces shall be presumed to act through center of mass of equipment in direction producing largest single anchor force.

C. Vertical seismic forces shall be presumed to act concurrently with horizontal seismic forces.

END OF SECTION

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SECTION 14 22 10
MODERNIZATION OF ELEVATORS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. Bidding documents:
   1. Bidders shall examine existing conditions. Any discrepancies which affect the elevator work or conditions adverse to the bidder's equipment shall be brought to Owner's Representative's attention during the pre-bid RFI period prior to the bid date. If no discrepancies are presented, changes required to accommodate bidder's equipment become the responsibility and cost to Contractor.
   2. Bidders are responsible to identify all required building related work at time of bidding and included with their bid documents.

B. A copy of the final contract with all attachments shall be onsite in the machine room at all times.

C. Contractor shall provide a lock-box for each machine room.

1.2 DEFINITIONS

A. Main Lobby: Ground Level unless otherwise indicated.

B. Fire Recall Level: As directed by local fire authority. As existing.

C. Alternate Fire Recall Level: As directed by local fire authority. As existing.

D. All retained existing equipment shall be of equal condition and life span as of new equipment.

E. Serviceability: It is recognized that each manufacturers' system contains components that are proprietary to the development of their systems. The Owner may wish to have the elevator system maintained by another technically qualified service provider and by submitting a bid for this project, the manufacturer shall guarantee that for a minimum of 20 years they will provide the following:
   1. Diagnostic, adjusting and monitoring tools for all components including documents, manuals, and wiring diagrams. Devices shall not self-destruct, require charging or exchange. Remote monitoring devices are excluded from this requirement, however if such devices are removed all wiring shall be neatly terminated, tied within a junction box and properly marked as to its content.
   2. Manufacturer shall guarantee to support the equipment for this project with regard to notification to Owner of system corrective updates, provide and install such updates at no cost to Owner.
   3. Provide contact information for their separate parts warehouse so that the Owner or designated service provider can order parts on a 24-hour basis and delivered within 48 hours. Parts may be provided from inventory when adequate stock exists. In some cases, parts will have to be special ordered from the factory or other vendor. Proprietary parts will be made available on an exchange basis.
   4. Provide a list of parts of each component manufactured and stored at the warehouse and the retail cost of each at close out of the project and estimated escalation cost. The cost of these parts is what would be charged to Owner or other service provider.
   5. Provide contact information for technical support so that the Owner or designated service provider can obtain technical support on a 24-hour basis to provide assistance in trouble shooting problems. Indicate hourly rate charged to Owner or designated service provider for such service.
   6. In the event that a company other than the Original Equipment Manufacturer (OEM) maintains the elevators, and if the equipment was unable to be repaired by the non- OEM

maintenance company, a factory-trained OEM technician would be required to assist (as it would if Contractor's own technician were in the same situation). If such an event was to occur, OEM Contractor would make its factory-trained technician available for assistance upon request of the Owner within three (3) business days, based on the original contractual hourly rates subject to established annual escalations. This shall survive any termination of the maintenance agreement.

7. The above will survive any termination of the maintenance agreement.
8. Contractor shall be defined as "Elevator Contractor".
9. Subcontractor shall be defined as any contractor contracted by either "Owner or Elevator Contractor".

1.3 DESCRIPTION

A. Examination of site:
   1. Contractor shall visit the building, examine the existing elevators and contract documents, determine condition of all retained components, space conditions, power supply and mainline disconnect.
   2. Make all surveys necessary to meet the requirements of this specification and compatibility to products provided.

B. Field measurements:
   1. Field verify dimensions before proceeding with the work.
   2. Coordinate related work by other trades.
   3. Contractor shall assume responsibility and provide full maintenance of the elevator equipment upon award of this contract and shall continue to do such throughout the modernization.

1.4 RELATED WORK INCLUDED BY OTHERS IN THIS SECTION UNDER THE ELEVATOR CONTRACT

A. Contractor shall visit the building, examine the existing conditions, power supply, standby/emergency power supply, emergency battery lowering, mainline disconnect, and include all work needed to ensure a fully code compliant modernization. Contractor or his sub-contractors shall perform this work, which may include but is not limited to the following:
   1. General:
      a. Self-closing and self-locking access doors and pit ladders (as req.)
      b. Providing supports to carry structural reaction, impact and uplift loads imposed by elevator equipment.
      c. Block-outs, pockets and chases in walls and floors for signals, fixtures, and conduit.
   2. Electrical work:
      a. Power feeders: Modification to existing, or installation and connection of three phase power, through fused mainline switches or circuit breakers and extended to terminals of controllers. Provide continuous ground where needed.
      b. Light circuits: Single-phase circuit through disconnects and extended to controller for car lights and fan.
      c. Communication circuit: Telephone circuit terminated at junction box of each controller.
      d. Illumination: Lights with guards, illuminating light switches and convenience outlets in pits, machine rooms, controller areas and overhead sheave spaces.
      e. Conduit: Installation of electrical conduit and pull boxes with pull wire between hoistways and remote locations of each indicator and control panel.
      f. GFCI Outlets: Provide in machine room and pits.
      g. Provide NEMA 4 approved electrical devices and conduits for all electrical installed below the lowest sill level.
   3. Fire Life Safety: Stand alone system.
      a. Sensing devices: Installation and or removal modification to smoke detectors, heat detectors, shunt trip, sprinklers, or products of combustion sensors in elevator lobbies,

machine rooms, hoistways and alternate fire recall floor with circuits terminated at junction box in machine rooms for emergency fire service operation.

b. Provide fire proofing as required by lode code authority.

4. If work by others is excluded from the elevator contractors' scope of work, they shall coordinate with all sub-contractors to complete all required building related work prior to inspection at no additional cost to the Owner.

1.5 RELATED WORK INCLUDED BY ELEVATOR CONTRACTOR IN THIS SECTION

A. Barricades: Full height self-closing self-locking barricades for protection of open hoistways during construction.

B. Painting: Field painting of prime-finish items constituting final finishes.

C. Contractor shall coordinate and perform all pretesting of all building systems prior to inspection at no additional cost to the Owner.

1.6 QUALITY ASSURANCE

A. Qualifications of Contractors:
1. General: The entire elevator installation shall be installed and maintained by the acceptable Contractors listed or as qualified by addendum. No portion of the work shall be subcontracted unless qualified and accepted by addendum.
2. Installer's qualifications: Installer must be a licensed, certified conveyance mechanic in the state where installation is located.

B. Sub-contractors:
1. Contractor shall be solely responsible for any and all of the work done by his sub-contractor or other employees and all orders or instructions from the Owner's Representative shall be through him to them. It shall be Contractor's duty to see that all of his sub-contractors commence their work properly at the proper time, and carry it on with due diligence so that they do not delay or injure either work or materials; and that all damage caused by them or their workmen is properly made good by them or by himself at his cost.
2. The use of sub-contractors is to be limited to work outside the scope of elevator construction work; for example, patching, painting, coring of walls, marble work and refinishing. Contractor of sub-contractor will be responsible for any drywall damage, patching and painting in regards to their scope of work.

C. Quality of work and workmanship:
1. When completed, the installation shall be modern in all respects.
2. All components specified as new shall be provided as new. All components specified to be retained may be provided as new at Contractor's option subject to approval of Owner's Representative. All retained components are to be examined, cleaned, adjusted, repaired and/or replaced with new parts. Contractor must be willing to accept all retained equipment on full maintenance without prorating.
3. All work performed shall be conducted in a workmanship type manner.

D. Requirements of regulatory agencies:
1. Codes: In accordance with the latest applicable edition requirements of the following and as specified:
a. A.D.A.: Americans with Disabilities Act
b. ASME: American Society of Mechanical Engineers - A17.1; Safety Code for Elevators and Escalators
c. CBC: Title 24; California Building Codes
d. CCR: Title 8; California Code of Regulations
e. IEEE
f. NEC: National Electric Code / NFPA 70.
g. NFPA-72
h. All local codes and Amendments and Administration, which govern

E. Permits, Inspections, and Taxes:
1. Arrange and pay for inspections by governing authorities.
2. Obtain and post operating permits per applicable code.
3. Arrange and pay for all applicable taxes.

F. Safety Policies and Practices:
1. Installation and maintenance contractors are required to follow their company's safety practices and policies
2. Installation and maintenance contractors are required to follow all practices and policies of the building management.
3. Installation and maintenance contractors are required to follow governing authorities' safety practices and policies.

1.7 SUBMITTALS

A. Shop drawings:
1. Submit three copies of the following prior to ordering any materials:
a. Layouts: Plan of machinery and hoistway spaces showing new equipment and existing equipment; include impact and static loads imposed on building structure and clearances around equipment.
b. Details: Submit details of cab shell and interiors, fixtures, and entrances.
c. Data: Indicate on layouts or separate data sheets; machine spaces heat release, power requirements, conduit runs outside of hoistways and machine rooms, car and counterweight roller guides, control systems, motor drive units and door operators.
d. Provide all structural submittals (as required) with an approved Professional Engineer stamp and signature.

B. Samples:
1. Provide samples of materials and finishes exposed to public view and additional, if specifically requested, 6 inch x 6 inch panels, 12 inch lengths or full size if smaller, as applicable.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and storage:
1. Protect equipment during transportation, erection and construction. Store under cover to prevent damage due to weather conditions. Replace damaged materials. Storage space on site will be available. Additionally, a storage container is required to properly secure and store all equipment, it shall be provided at no cost to the Owner.

B. Handling:
1. Owner's Representative has the first right of refusal to retain any elevator components that are to be removed and modernized with new equipment. All removed components shall remain property of the Owner's Representative, until the Owner's Representative notifies Contractor, in writing, of removed components that Owner's Representative would like to retain. All remaining elevator equipment not to be retained by the Owner's Representative or reused by Contractor shall be promptly removed from the building by Contractor at no cost to the Owner's Representative, and become the property of Contractor.
2. Contractor shall make every attempt to recycle removed elevator equipment. Contractor shall correct any damage to building surfaces and surrounding areas if damaged during removal of this equipment, at no cost to the Owner's Representative.

C. Building operations:
1. The building will remain in operation during the execution of this contract. Cooperate with building management in scheduling work in such a way as not to cause interruption of or interference with the building operations.

D. Electrical shutdowns:
   1. Temporary electrical shutdowns will not be allowed except for brief periods to be scheduled outside normal hours and at least forty-eight (48) hours in advance and approved by Owner's Representative.

1.9 WARRANTY

A. Guarantee and Warranty:
   1. Provide special project warranty, signed by Contractor, Installer and Manufacturer, agreeing to replace/repair/restore defective materials and workmanship of all work performed which may develop within one (1) year from final date of completion and acceptance of the **entire installation**. "Defective" is hereby defined to include, but not by way of limitation, operation or control system failures, performances below required minimums, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration and similar unusual, unexpected and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF SYSTEMS:

A. Elevator No. 1:

1.	Type:	Traction Elevator
2.	Capacity:	Match Existing
3.	Speed:	Match Existing
4.	Stops:	5, at Basement, 1,2, 3, 4
5.	Openings:	5, Inline
6.	Travel:	Existing
7.	Control:	Soft Start AC
8.	Operation:	New Microprocessor Simplex Selective Collective
9.	Machine Location:	Basement Side
10.	Special Operations:	
	a. Fire Emergency Service	
	b. Emergency Battery Lowering	
11.	Door Operation:	Provide New
12.	Door Protection:	Provide New
13.	Guide Rails:	Retain
14.	Guide Shoes:	Provide New
15.	Motor	Provide New
16.	Buffers:	Retain
17.	Car Frame & Platforms:	Retain
18.	Power Unit:	Provide New
19.	Controllers:	Provide New
20.	Car Operating Panels:	Provide New
21.	Car Position Indicators:	Provide New
22.	Hall Position Indicators:	Provide New
23.	Service Cabinet:	Provide New
24.	Communications:	Provide New
25.	Hall Button Stations:	Provide New
26.	Hall/Car Lanterns:	Provide New
27.	Handicap Requirements:	Provide New, as Required
28.	Wiring:	Provide New
29.	Car Enclosure:	Provide New per Manufacturers Standards
30.	Hoistway Entrances:	Provide New
31.	Miscellaneous Items:	
	a. Key Operated Hoistway Access	

b. Seismic Requirements
c. Lobby Park Key Switch
d. Clean hoistways, machine rooms and equipment; paint machine room floor, pit floor, car top, and all existing metal work
e. Top of car guardrail Provide new (as required)

2.2 MATERIALS

A. Aluminum: Alloy and temper best suited for anodizing finish specified.

B. Plywood: PS-1, A-D exterior Grade Douglas Fir, fire retardant treated.

C. Sheet steel: ASTM A366, uncoated, pickled, free from defects.

D. Sound deadener: Fire retardant; spray, roller or adhesive applied; 3/16" thick.

E. Stainless steel: ASTM A167; type 302 or 304.

2.3 FINISHES

A. Exposed-to-view surfaces:
1. Provide as follows unless otherwise specified.
   a. Aluminum: Clear anodized finish.
   b. Sheet steel:
      1) Shop prime: Degrease clean of foreign substances and apply one coat of corrosion inhibiting primer compatible with finish paint selected. Hoistway items visible to public shall be painted one additional coat of black paint.
      2) Finish paint: Three coats baked enamel; sand each coat smooth; color as selected.
   c. Stainless steel:
      1) Plain: Satin, directional polish, No. 4 Mirror directional polish, unless otherwise specified.
   d. Touch-up:
      1) Prime surfaces: Use same paint as factory for field touch-up.
      2) Finish painted surfaces: Refinish whole panel with shop prime and finish paint as specified above.

B. Non-exposed-to-view surfaces:
1. Degrease or remove any rust and shop paint manufacturer's standard corrosion inhibiting primer.

2.4 AUTOMATIC OPERATION

A. General operation of individual elevators:
1. Provide a non-proprietary diagnostic microprocessor-controlled dispatching system, based on real time calculations, designed to monitor all types of traffic and sufficiently flexible so that it can be modified to accommodate changes in traffic patterns.
2. Serial link communications: Provide a distributed processing network consisting of localized processors located in machine rooms, car stations, hall stations and top of car to allow system to make fast decisions based on data shared by the processor involved in the different operations of the elevators. For group dispatch operations, all elevators in the group shall be capable of acting as a group common dispatcher as the need arises.
3. Fault diagnostic system: Provide Owner's Representative with all hardware such as on-board LED diagnostics, hand held device or laptop computer, as standard with manufacturer, and supporting software documentation. Diagnostic system shall be capable of determining faults most difficult to find, as well as be capable of performing all code required testing.
4. The system shall be flexible, irrespective of the number of elevators in normal service.

B. Simplex selective collective operation:
1. Arrange for simplex selective collective automatic operation. Operate elevators from a single riser of landing buttons and from operating device in car.

2. Momentary pressure of one or more car or landing buttons, other than those for landing at which car is standing, starts car, and causes car to stop at first landing for which a car or landing call is registered corresponding to direction in which car is traveling. Stops made in order in which landings are reached, irrespective of sequence in which calls are registered.
3. Double door operation not permitted. If an up-traveling car has a passenger for an intermediate floor and a down call is registered at that floor, with no calls above car, it travels to floor, opens door to let passenger out, then lights down direction arrow in hall lantern and accepts waiting passenger without closing and reopening doors.

2.5 SPECIAL OPERATIONS

A. Inspection operation:
1. Provide key-operated hoistway access device and car top operating device. Key switches shall be mounted in door frames with a separate cover plate at terminal landings.

B. Operation under fire or other emergency conditions:
1. Provide special emergency service to comply with current ASME and CCR Title 8, CBC Title 24, and local codes having jurisdiction.
2. Provide Phase 1 recall switch at main floor elevator lobby.
3. Key switches at main floor shall be integrated in hall button station hoistway entrance jamb with engraved instructions.

C. Lobby Park:
1. Arrange control system to enable the elevator, from either a key switch or time clock, to bring the elevators to the main lobby, cycle the doors and shut down. Leaving only the door open button functional. All emergency service operations shall over ride this feature.

2.6 DOOR OPERATION

A. Passenger type:
1. Provide door times available as specified under "Design Criteria."
2. Car and hoistway doors shall open and close simultaneously, quietly and smoothly; door movement shall be cushioned at both limits of travel. Door operation shall not cause cars to move appreciably.
3. Door hold open times shall be readily and independently adjustable when car stops for a car or hall call. Main floor door hold times shall be adjustable independent of other floors.
4. Provide closed loop regulated speed performance, onboard diagnostics, adjustable times, nudging, and test switches.

B. Door operator:
1. Provide new heavy-duty master type solid state closed loop door operators mounted on car enclosure utilizing minimum 12-guage support angles to isolate from direct mounting of operator on the car top.
2. Pre-approved closed loop heavy duty door operators:
   a. GAL Linear
   b. GAL MOVFR
3. Provide code compliant door weight data tag.

C. Door Protection:
1. Elevator No. All: Remove existing door protection devices and provide new electronic optical 3D scanning type:
   a. Provide a door protective system which does not rely on physical contact with a person or object to inhibit door movement or initiate door reversal.
   b. Pre-approved optical door sensors:
      1) Elevator Contractor
      2) Adams GateKeeper Max
      3) Formula Systems
      4) Janus Pana40 Plus
      5) Janus Pana Chrome 3D, with voice annunciation

6) Tritronics Leading Edge

c. The system shall be able to detect a 2-inch diameter rod introduced at any position within the door movement and between the height of 2 inches and 63 inches above sill level.

d. Detection of intrusion into the protected area shall cause the doors, if fully open, to be held in the open position and, if closing, to reverse to fully open position.

e. If doors are prevented from closing for an adjustable period of 15 to 45 seconds or upon activation of fire emergency service, they shall proceed to close at reduced speed and a loud buzzer shall sound. Door closing force shall not exceed 2-1/2 ft.-lb. when door re-opening device is not in operation.

f. For side-opening doors, the detector for the strike jamb side shall be recessed, flush with strike jamb.

2.7 SIGNALS AND OPERATING FIXTURES:

A. General:

1. Provide signals and fixtures as shown and specified. Location and arrangement of fixtures shall comply with disabled access requirements.
   a. Passenger Elevator Buttons: Provide minimum 1-inch diameter mechanical, with fully illuminated buttons with LED's and engraved identifications. Buttons shall be raised 1/8 inch from surrounding surface with square shoulders. Survivor, Bruiser or equal.
   b. Switches: Toggle type typically or key operated where noted.
   c. Provide six (6) keys for each elevator keyed device, with proper labeled identification upon turnover of elevator.
   d. Cabinets: Provide with pulls, concealed hinges and doors mounted flush with hairline joints to adjacent surface.
   e. Arrangement: Arrangement of fixtures shall generally conform to that specified, but components may be rearranged, if desired, subject to Owner's Representative's approval.
   f. Engraving: Of size indicated; color backfill with epoxy paint in contrasting color as selected. No applied engraved plates.
   g. Lamps: Miniature LED type.
   h. Audible Chimes: Electronic adjustable audible chimes; bell type gong not acceptable.
   i. Provide floor passing signal of the adjustable electronic audible chime type.
   j. Tactile Markings: Provide raised Braille and alpha characters, numerals or symbols adjacent to operating buttons and devices used by the public according to local codes. Indications may be engraved directly on faceplates or separate plates flush mounted with hairline joints and concealed mechanical fasteners. Plates shall be of same size and shape as buttons or integral "fishtail" type.
   k. Acceptable manufacturers: EPCO, ERM, MAD, or INNOVATION, fixtures with 5/8" engraved identifications. Operation of car or hall button shall cause button to illuminate. Response of car to car or hall call shall cause corresponding button to extinguish.
   l. Faceplates: Provide of material and finish as indicated and specified; 1/8-inch minimum thickness with sharp edges relieved. Faceplates shall be sized to cover holes left by removal of existing fixtures where new fixtures are provided and provided with engraved fire sign, per A17.1. New faceplates shall cover all existing holes or Contractor shall patch at no additional cost to the Owner.
   m. Audible chimes: Electronic adjustable audible chimes from 75 to 85 dB in elevator lobby 3' - 0" above floor and 3' - 0" away from elevator entrance; bell type gong not acceptable.

B. Car operating panels:

1. General: Provide buttons numbered to conform to floors served and the following:
   a. Locate top operating button at 48 inches above floor.

b. Locate emergency stop switch and illuminated alarm button in bottom row at 35 inches above floor.
c. Provide "Door Open" and "Door Close" buttons located above emergency stop and alarm of same design as car button.
d. All signage required by local codes shall be engraved and painted as directed by Owner's representative.
e. Provide fire emergency features, per code. Provide FEO-F1 key switch for fire service unless local code requires different.
f. Make provisions for card readers in Elevator No. 1.

2. Provide one new panel per car; integrate cabinets, buttons and engraving into swing front return panels without applied faceplate. Entire front return shall swing on concealed hinges with concealed locking means for servicing.

C. Car position indicators:
1. Provide car position indicators with 2 inch indications corresponding to floor designations with matching direction arrows.
a. Provide new digital alpha numeric type segmented LED readout indicator with minimum two-inch high indications mounted integral with each car operating panel.

D. Service cabinet:
1. Provide new cabinet, door with a lock and concealed hinge as an integral part of car operating panel mounted with flush hairline joints. Cabinet door shall be provided with a flush glazed window of required size to hold elevator-operating permit, mounted horizontally. Service cabinet shall contain the following:
a. Independent service switch
b. Two-speed ventilation switch (Hi-Off-Low)
c. Light switch as applicable
d. Inspection switch, key operated
e. Duplex GFI convenience outlet
f. Buzzers as required
g. Constant pressure test switch for emergency car lighting
h. Card reader over-ride switch-key operated

E. Communication equipment:
1. Provide a new complete communication system in compliance with ADA regulations consisting of a combination speaker/microphone, amplifier, automatic dialer with 4 number rollover capability and matching car station push button with telephone symbol to activate system and acknowledgment lights. Mount in car operating panel behind a pattern of holes, wire to machine room and program automatic dialer as directed by Owner’s Representative.

F. Hall button fixtures:
1. Each fixture shall contain buttons, which light to indicate hall call registration and extinguish when call is answered. Provide intermediate fixtures with two buttons and terminal fixtures with one. Engrave fire-exiting instructions on faceplates. Provide minimum of two fasteners at top and bottom of faceplate.
a. Provide one riser of hall button stations.

G. Hall position indicators:
1. Provide with indications corresponding to floor designations with matching direction arrows.
a. Provide new digital alphanumeric type segmented LED readout indicator with minimum two-inch high indications. Combine with hall lantern.

H. Car lanterns:
1. Manufacturer's standard dual car riding lantern mounted at a maximum height above floor. Lens shall be flush with faceplate or face of jamb.
2. Lantern illuminates and chimes as doors open. Provide single chime for up direction and double chime for down direction. Chime sound level shall be at 10 decibels over ambient.

I. Disabled access requirements:
   1. Provide to meet local codes having jurisdiction including handrail and button configuration.
      a. Car operating panels: Provide raised Braille and alpha characters, numerals or symbols to the left of operating buttons and devices used by the public. Indications may be engraved directly on faceplates or separate plates flush mounted with hairline joints and concealed mechanical fasteners. Plates shall be of same size and shape as buttons. Raised characters shall be white on a black background with Braille designations directly below the character. Provide "star" at main egress landing.
      b. Entrances: Provide raised Braille and alpha characters, numerals or symbols similar to those for car stations of size required by governing authority. Locate on each entrance jamb at 60 inches above floor indicating floor designation. Material and finish of plates shall match hall button station faceplates. Material and finish of plates shall be white on black. (CA only) Provide with contrasting background. Braille designation shall be to the bottom of the raised character. Provide mounting means similar to those on car panels. Braille designation shall be to the bottom of the raised character. Provide "star" at main egress landing.
      c. Entrances: Provide plate with elevator number for first floor entrance. Character shall be a minimum of 3". For Destination Dispatching Systems, Braille shall include the elevator number or letter designation as well as the floor designation. Material and finish of plates shall be white on black.

2.8 WIRING

A. General:
   1. Provide all necessary wiring and 25% spares between cars and controllers and to all remote-control stations; minimum of eight. Furnish shielded wires in cables for all communications card readers, cameras, digital displays, and speakers. Include four additional pairs of shielded spares and two RG-6 coaxial cables or equivalent, for each car. Electrical wire runs will be free of splices or connection unless at designated junction points.

B. Traveling Cables:
   1. Use minimum number of traveling cables. Include shielded wires and spares as noted above. Cord thoroughly and protect cables from rubbing against hoistways or car items. Provide with steel cable core and properly anchored to relieve strain on individual conductors.
   2. All traveling cables shall be wired from machine to elevator, without junction box or spliced connections.

C. Hoistway Wiring:
   1. All wiring shall be neatly terminated, tied within a junction box and properly marked as to its content.
   2. If junction boxes are used, NEC approved terminal strips shall be used and properly identified.
   3. No splices shall be allowed.

D. Work light and GFCI convenience outlet:
   1. Provide on top of car with protective plastic lamp guard.
   2. Provide compact fluorescent type (CFL)

E. Stop switch:
   1. Provide in each pit. Provide NEMA 4 enclosure.
   2. Provide on each top of car.

F. Alarm gong:
   1. Provide on top of each car to be actuated by corresponding alarm button or emergency stop switch.

G. Auxiliary disconnect switches:
   1. Provide as required in remote controller rooms or at remote equipment not in view of mainline switches; include all wiring and conduit.

2.9 CAR ENCLOSURES

A. Passenger cars:
   1. Provide an emergency car lighting unit mounted on top of car, battery driven and self-rechargeable. Upon outage of normal power the unit shall, within 5 seconds, light two lamps as part of normal car lighting. The unit shall have sufficient capacity to keep the lights in continuous operation for four hours and the alarm bell for one hour. Provide a readily accessible means for testing the unit in service cabinet. Light fixtures mounted in car front returns or operating panels are not acceptable. Illuminate lights directly over car operating panels.

2.10 HOISTWAY ENTRANCES; PASSENGER TYPE:

A. General:
   1. Retain existing or provide new as specified.

B. Hangers and Tracks:
   1. Provide all new door tracks and hanger assemblies. Sheave type with two-point suspension. Steel sheaves with flanged groove and resilient sound-absorbing tires. Minimum 2-1/2-inch diameter for hoistway, 3 inch for car. Manufacturer's heavy- duty tracks and ball or roller bearing with adjustable up thrusts.

C. Hanger headers:
   1. Retain existing. Modify for new door tracks, reinforce and refinish.

D. Struts:
   1. Retain existing, clean and paint.
      a. Provide rubber door stops.

E. Closers:
   1. Provide new cable relating torsion spring mechanical type or broken arm jack knife type as required for door assembly.

F. Dust and hanger covers:
   1. Retain existing, clean and refinish with black paint. Replace damaged and missing dust covers.

G. Fascia, toe and head guards:
   1. Retain existing, modify to comply with code, refinish with black paint and refasten for greater rigidity.

H. Interlocks:
   1. Provide all new. Equip each hoistway door with a tamper-proof interlock which shall prevent operation of the car until doors are locked in the close position as defined by the Code and shall prevent opening of doors at landing from corridor side unless car is at rest at landing in leveling zone or, hoistway access switch is used. Provide all new type “SF” high temperature wiring for interlock circuits.

I. Pick-up roller assemblies:
   1. Provide all new pick-up roller assemblies as required for door operating equipment furnished.

J. Door restrictor:
   1. Provide new, door restrictor device compatible with new door equipment.

K. Sills:
   1. Retain existing, power clean to metal and refinish, full length of sill.

L. Limit Switches:
   1. Provide new

M. Frames:
1. Retain existing. Clean and refinish as scheduled.

N. Hoistway doors:
1. Provide New.
2. Provide new full height astragals and missing or damaged non-vision wings matching finish of door panels. Contractor must use the original reinforcing on existing hoistway and car doors for mounting hangers, pickup rollers, drive vanes, etc. If original reinforcing is not reusable for drive vanes and pickup rollers, Contractor shall furnish new reinforcing (minimum of 1/4" thick plate) welded to the door face. A minimum of four (4) 5/16" threaded bolts is to be used for attachment to the reinforcing plate. Where slotted holes are provided in the attachment block, a 1/4" dowel pin is to be fitted after doors locks are set up. Clean and refinish door panels as scheduled. Door panels to be refinished by others. Vandal resistant paint. Remove door panels before painting.

2.11 ELEVATOR EQUIPMENT

A. Design Criteria:
1. Performance:
a. Contract Speed: Maximum ten percent (10%) speed variation under any loading condition in the up direction.
b. Motion Time: From start to stop of elevators motion as measured in both directions for a typical one floor run under any loading condition.
1) 8.5 seconds
c. Door Open Times:
1) 2.0 seconds
d. Door close times: Minimum, without exceeding kinetic energy and closing force, allowed by code.
e. Door dwell times: Comply with A.D.A. formula and provide separate adjustable timers with initial settings as follows:
1) Main lobby hall call: 5.0 to 6.0 seconds.
2) Upper lobby hall call: 5.0 to 6.0 seconds.
3) Car call: 5.0 to 6.0 seconds. Choose one.
4) Interruption of door protective device: Reduce dwell to 1 second.
f. Leveling: Within 1/4 inch under any loading condition. Level into floor at all times, do not overrun floor and level back.
2. Operating qualities: Owner's Representative will judge riding qualities of cars and enforce the following requirements. Make all necessary adjustments.
a. Acceleration and deceleration: Starting and stopping shall be smooth and comfortable, without obvious steps of acceleration. Slowdown, stopping and leveling shall be without jars or bumps. Elevator shall start movement within .5 seconds of fully closed doors. Stopping upon operation of emergency stop switch shall be rapid but not violent.
b. Horizontal Acceleration (ISO A95 Scaling): Maximum 12 mg peak-to-peak measured at full speed for full travel in both directions.
c. Vertical Vibration: Ride shall be free of vibration throughout acceleration, full speed and deceleration for full travel in both directions.
3. Sound control: (A Scaled – fast – Lmax over the duration of the operation).
a. Vibration: Sound isolate machines and motor drives from beams and building structure to prevent objectionable noise and vibration transmission to occupied building spaces.
b. Airborne noise: Maximum acoustical output level of:
1) 85 dB measured in machine room. With the meter located 3' - 0" from each machine room door at floor level.
2) 55 dB measured in elevator cars during all sequences of operation.
3) 50 dB measured in elevator lobbies. From the nearest staff work station to the elevator lobby.

2.12 HOISTWAY EQUIPMENT

A. Guide rails and brackets:
1. Retain existing rails, realign, clean, check, tighten and replace Code non-complying brackets, fishplates and bolts. Provide log of the alignment corrections to the Owner's Representative.

B. Guide shoes:
1. Provide new guide shoes of the roller type with neoprene tires, minimum 3/4-inch-wide and fully adjustable spring loaded to provide continuous contact with rail surfaces. Balance car to insure equal guide shoe pressure on all wheels and not exceed manufacturer's recommendations. Nominal roller diameter shall be 4" 6".

C. Buffers:
1. Retain existing.

D. Car frame and platform:
1. Retain existing car frame. Clean down and tighten frame bolts. Static balance weight to be added as required.

2.13 MACHINE ROOM EQUIPMENT

A. General:
1. Provide equipment to fit existing space and structural limitations. Coordinate related electrical, structural and mechanical work with other trades.

B. Controller:
1. Integral, floor or wall mounted as applicable to space conditions. Include door operating relays combined with controller. Provide solid state soft starting with starting switches rated at minimum 57% of horsepower rating. IEC method of line starter application is unacceptable. Provide three (3) manual reset overload relays, one in each line and reverse phase relay. Provide externally mounted permanently identified junction boxes on controller cabinets for termination of communication circuits. Design controller to accommodate future stops. Pre-approved controllers:

C. Elevator battery emergency lowering operation:
1. Provide a battery driven unit which will initiate operation of the Protective Circuit and lower elevator to bottom landing in the event of a power failure.
2. Service shall be restored automatically upon restoration of normal power supply.
3. Arrange with an exposed method of testing.
4. Arrange circuitry so that, if the mainline switch is open when the power transfer takes place, the elevator will not respond to the operation of the protective circuit.
5. Provide a double pole-isolating switch on the battery unit to disconnect the battery output.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install per manufacturer's requirements, those of regulatory agencies and as specified.

B. Welded Construction:
1. Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustments, inspection, maintenance and replacement of worn parts.
2. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation:
1. Mount rotating and vibrating elevator equipment and components on vibration- absorption mounts, designed to effectively prevent transmission of vibrations to structure and thereby, eliminate sources of structure-borne noise from elevator system.

D. Lubrication:
1. Lubricate operating parts of systems as recommended by manufacturer.

E. Hazardous Disposal Certification:
1. Contractor to provide oil and hazardous waste removal documentation per required EPA standards. Provide copy of documentation to Owner.

F. Alignment:
1. Coordinate alignment of hoistway entrances with elevator guide rails, for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe workable dimensions at each landing.
2. Align guide rails plumb and parallel with maximum deviation of 1/16 inch. Anchorage of guide rails in pits shall not compromise waterproofing.

G. Graphics:
1. Provide graphics visible to public as selected by Owner's Representative.

H. Manufacturer's nameplates:
1. Manufacturer's nameplates, trademarks or logos not permitted on surfaces visible to public.

I. Cleaning of the installation:
1. After the installation of each elevator has been completed and immediately prior to the carrying out of the tests, the machine room and all equipment therein, the elevator hoistways including outside of car and all ledges and similar areas, the elevator pit and equipment therein, and all door hanger runners, guides, tracks and sills shall be thoroughly cleaned down, preferably with vacuum cleaning equipment, and all dust, fluff, dirt, grit, excessive oil and grease and rubbish shall be removed from site.

J. Finish painting after tests:
1. After satisfactory completion of the tests, any damage to the paint work shall be made good and the installation re-cleaned, if necessary, after which at least one final coat of gloss oil resistant or enamelized paint shall be applied by brushing or spraying in Contractor's customary colors to all the existing and new equipment in the machine room and also to such items in the hoistway or elsewhere which have received only a primer coat.
2. Painting shall be performed either during normal working hours or after hours at no additional cost to the Owner.

K. Painting of machine room floor and pit floors:
1. After the completion of the entire installation, the floor of each machine room and pit areas shall be thoroughly cleaned down and brush painted with one coat of traffic paint having oil resistant properties. Pit floors shall be painted after the completion of the waterproofing. Owner’s Representative will advise the color.
2. Painting shall be performed either during normal working hours or after hours at no additional cost to the Owner.

3.2 NOISE CONTROL

A. General:
1. Contractor, in the preparation and the execution of the work, shall recognize the particular and mandatory requirements of the remodeling project due to the character of the work and the use occupancy of the building.
2. Contractor shall perform all noisy work as directed by Owner's Representative.

B. Building operations:
1. Noise and vibration generated by this construction for this work may, at times, create a problem for the operations of the building. In the event the noise produced by the construction work conflicts with the building function, Contractor, at the request of the Owner's Representative, shall reduce or stop the noise.
2. All disruptive work including removal of old materials and deliveries of new materials shall be done on overtime at no additional cost to Owner.
3. All disruptive work will be performed after hours at no additional cost to Owner.

C. Measurement:
1. The noise level shall be measured on the "A" Scale of a sound level meter as follows:
a. With the meter located 3' - 0" from the nearest staff work station to the elevator lobby, the sound level shall not exceed 65 db.
b. With the meter located 3' - 0" from outside of each machine room door at floor level, the sound level shall not exceed 70 db.
c. With the meter located 3' - 0" from any hoistway door at any level, the sound level shall not exceed 70 db.

D. Types of noise generating work:
1. All heavy demolition (concrete walls and floors).
2. All grinding, chipping, pounding, sanding and cutting of holes and core drilling.

3.3 FIELD QUALITY CONTROL

A. Regulatory agencies inspection:
1. Upon completion of elevators, Contractor shall provide instruments, weights and personnel to conduct test required by regulatory agencies. Contractor shall submit a complete report describing the results of the tests.

B. Examination and testing:
1. When installation is ready for final acceptance, notify and assist Owner’s Representative in making a walk-through inspection of entire installation to assure workmanship and equipment complies with contract documents. Provide equipment to perform the following tests:
a. One-hour heat and run test with full load in car. Perform for one car of each duty.
1) Stop car at each floor in each direction.
2) Verify that temperatures do not exceed manufacturer’s motor ratings.
3) Performance and leveling tests shall be made before and after heat and run test.
b. Check and verify operation of all safety features and special operations.
1) Measure horizontal acceleration.
2) Measure acoustical output levels in machine room, lobbies and cars.

C. Correction:
1. Make corrections to defects or discrepancies at no cost to Owner’s Representative. Should discrepancies be such that re-examination and retesting is required, Contractor shall pay for all costs including those of Owner’s Representative’s fees.

D. Final acceptance:
1. Final acceptance of the installation will be made only after all corrections are complete, final submittals and certificates received and the Owner’s Representative is satisfied and the installation is complete in all respects.

3.4 INSTRUCTIONS

A. Instruct Owner's personnel in proper use of each system.

3.5 PROJECT RECORD DOCUMENTS

A. As-built drawings:
   1. Contractor shall maintain at the job site a separate and complete set of contract drawings which will be used solely for the purpose of recording changes made in any portion of the work during the course of construction, regardless of the reason for such change.
   2. Changes, as they occur, will be marked on the record set of drawings on a daily basis.

B. Record drawings:
   1. Contractor shall prepare "as-built" drawings in duplicate of any changes to electrical work on prints supplied by the Owner's Representative. During the course of construction, actual locations to scale shall be shown for all runs of mechanical and electrical work, installed in walls and floors or otherwise concealed. This shall cover all piping, electrical wiring; whether in conduit or cable, duct work, etc. shall be located, in addition, by dimension. All services shall be identified in ink on the prints.
   2. In addition, Contractor shall keep a complete record copy of the plans and specifications for the use in preparing "as-built" plans and specifications at the end of the job. Contractor shall sign and date the prints and deliver them to the Owner's Representative.

END OF SECTION

SECTION 20 05 00
SPECIAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Special Mechanical Requirements, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

C. Systems Included:
1. Special mechanical requirements.
2. Products:
   a. Access doors, panels, and frames.
   b. Covers for exposed vertical piping.
   c. Equipment guards.
   d. Motors and controls.
   e. Rain hoods and counter flashings.
   f. Penetrations.

D. Drawings Use and Interpretation:
1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
2. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
3. Field measurements take precedence over dimensioned drawings.
4. Piping and ductwork plans are intended to indicate size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.
5. Field verify locations and arrangement of existing systems and equipment.

E. Installation of Systems and Equipment:
1. Installation is subject to clarification as indicated in reviewed Shop Drawings and Field Coordination Drawings.
   a. Generally, lay out piping requiring gravity drainage first; then lay out large pipe mains, ductwork and electrical conduit.
   b. This procedure is intended to promote orderly installation, but not to establish trade precedence.
   c. Dimensions indicated are limiting dimensions.
   d. Do not use equipment exceeding dimensions indicated on detail drawings or arrangements that reduce required clearances or exceed specified maximum dimensions.
   e. In mechanical equipment room aisles, maintain clear head room between floor and underside of ducts, pipes, and equipment to allow for future replacing of equipment and major components (e.g., coils, fans, heat exchangers, pumps).

F. Description of Systems:
1. Provide materials resulting, upon completion, in functioning systems in compliance with performance requirements specified, and modifications resulting from reviewed Shop and Field Coordination Drawings.

G. Seismic Bracing:
1. See Section 20 05 48.

1.2 QUALITY ASSURANCE

A. Perform work in accordance with following codes:
   1. State and local building, plumbing and mechanical codes.
   2. American Gas Association.
   3. National Electrical Code.
   4. National Fire Protection Association.
   5. Authorities Having Jurisdiction (AHJ).

B. Use only prime quality, new materials, apparatus and equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Structural steel support drawings and calculations signed and sealed by Specialty Structural Engineer.

1.4 PROTECTION

A. Provide covering and shielding for equipment provided to protect from damage.

B. Repair, restore and replace damaged items.

C. Protect nameplates on motors, pumps and similar equipment.

D. Protect plumbing fixtures and brass or chromium plated trim, valves and piping from damage.

E. Keep dirt and debris out of pipes and ducts by capping or plugging open ends.
   1. Keep plug or cap in place until final connections are made.

1.5 JOB CONDITIONS

A. Avoid interference and interruption of existing utilities and services.
   1. Schedule work which will cause interference or interruption in advance with Owner, Construction Manager, Architect, authorities having jurisdiction, and affected contractors.

B. Keep roads clear of materials and debris.

C. Examine Contract Documents to determine how other work will affect execution of mechanical work.

D. Examine site and become familiar with existing local conditions affecting work.

E. Determine and verify locations of existing utilities on or near site.

F. Make arrangements for and pay for necessary permits, licenses, and inspections.

G. Air Quality Permits: Contractor shall be responsible for obtaining EPA air quality permits. Coordinate permitting process with Owner.

H. Record drawings:
   1. Keep a complete set of mechanical drawings in job site office for indicating actual installation of mechanical systems and equipment.
   2. Use this set of drawings for no other purpose.
   3. Where material, equipment, or system components are installed differently from that indicated, indicate such differences clearly and neatly.
   4. At project completion, submit record set of drawings in accordance with Division 01.

I. Operation and Maintenance Data:
   1. See Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Motors:
1. Alternating Current (AC) Motors
   a. Base:
      1) Baldor-Reliance.
   b. Optional:
      1) Century Electronics; E-Plus.
      2) General Electric; Energy Saver.
      3) Westinghouse Motor.
2. Electronically Commutated Motors (ECM)
   a. Base:
   b. Optional:
      1) EBM-Papst.
      2) Fasco.
      3) Maxon Precision.
      4) Ziehl-Abegg Inc.

B. Shaft grounding ring for motors:
1. Base:
   a. Aegis.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 ACCESS DOORS, PANELS, AND FRAMES

A. Access Doors, Panels and Frames:
1. See Section 20 05 10.
2. Where not specifically indicated on Drawings, provide access panels and/or doors at walls, and inaccessible ceilings, to permit access to equipment, devices and piping requiring service, adjustment, or inspection.
3. Provide fire-rated access panels within fire-rated assemblies.
4. Size:
   a. As required to allow access, inspection, service, and removal of items served.
   b. Minimum 18 IN x 18 IN.

2.3 COVERS FOR EXPOSED VERTICAL PIPING

A. Covers for Exposed Vertical Piping:
1. 18 GA stainless steel (type 302) with No.4 finish.
2. Extend from 2 IN above ceiling to equipment or island partition.
3. Size covers to contain number of pipes served.
4. Minimize number of covers by enclosing maximum number of pipes in each drop.
5. Anchor to equipment or partition.
6. Fasten seams and joints with stainless steel pop rivets.

2.4 EQUIPMENT GUARDS

A. Equipment guards:
1. Use suitable structural frames with minimum 12 GA, 3/4 IN galvanized mesh, or expanded metal mesh.
2. Attach to equipment by removable clips and bolts with wing nuts, or other approved connectors.
3. At belts, provide opening for measuring RPMs.
4. Provide at belts, couplings, moving machinery and equipment in accordance with OSHA.
5. Design for easy access to belts and other items requiring replacement.

B. Rotating equipment warning plates:
   1. 1/16 IN rigid plastic, Setonply, Emedolite or bakelite with four edges beveled; or engraved aluminum with red enamel background and natural aluminum border and letters.
      a. Two 3/8 IN mounting holes.
      b. Lettering size: Minimum 1/2 IN high.
      c. Fasteners: Commercial quality, rust resisting nuts and bolts with backwashers, self-tapping screws or rivets.
      d. Lettering: "WARNING: ROTATING EQUIPMENT CAN BE REMOTELY/ AUTOMATICALLY STARTED AND STOPPED".

2.5 MOTORS AND CONTROLS

A. Motors:
   1. Provide motors indicated in Mechanical Specification Divisions.
   2. Ball or roller bearing type.
   3. Starting and running characteristics consistent with torque and speed requirements of driven machine.
   4. Motor efficiency:
      a. Premium efficiency.
      b. NEMA Standard MG-1, part 31.
      c. Indicate full load efficiency on each nameplate.
   5. Rated in accordance with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 40 °C above ambient with service factor of 1.15.
   6. Motor powers as scheduled.
   7. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
   8. Do not include service factor when selecting motor power.
   9. Provide for items which require electric drive.
   10. Power input sizing:
      a. AC Motors less than 1/2 HP:
         1) 120/1/60
      b. AC Motors 1/2 HP and over:
         1) 480/3/60
      c. EC Motors less than 1 HP:
         1) 120/1/60
         2) 208/1/60
      d. EC Motors 1 HP and over:
         1) 208/1/60
         2) 208/3/60
         3) 480/3/60

B. Motors for use with variable frequency drives (VFDs):
   1. Provide inverter duty.
   2. Provide with following to prevent bearing current damage:
      a. Shaft grounding ring:
         1) Discharges shaft currents to ground through use of frictionless conductive microfibers surrounding motor shaft.
         2) Maintenance required: none.
         3) Design to last for service life of motor.
         4) RPM limitation: none.
         5) Manufacturer: Aegis SGR.

C. Electronically Commutated Motors (ECMs):
   1. Permanently lubricated ball bearing type.
   2. Motor controllable to 30 percent of full speed.

3. Built-in soft start/speed ramps.
4. Motor to be complete with and operated by an integrated speed controller/inverter. Speed controller options:
   a. Motor mounted potentiometer.
   b. Remote mounted potentiometer.
   c. Low voltage inputs.

D. Motor controls and wiring for controls:
1. Provide complete installation of controls and wiring for controls for Mechanical Specification Divisions packaged/pre-wired equipment.
   a. Include line voltage controls, low voltage controls, control switches, starters, disconnects, conduit, and wiring.
   b. Locate disconnects on outside of equipment enclosures or guards.
2. Starters, disconnects, conduit, and wiring furnished under Mechanical Specification Divisions shall comply with applicable Electrical Specification Divisions.
3. Where equipment is specified with packaged/pre-wired controls, but is furnished instead with loosely shipped components that require field wiring, coordinate complete installation and assume costs.

2.6 RAIN HOODS AND COUNTER FLASHINGS

A. Rain hoods and counter flashings not exposed to view:
1. Stainless steel: Minimum 20 GA.
2. Sheet copper: Minimum 24 OZ/SF.

B. Rain hoods and counter flashings exposed to view:
1. Material specified in Section 07 62 00.

2.7 PENETRATIONS

A. Maintain fire and smoke ratings where mechanical items penetrate fire and fire/smoke rated building elements.

2.8 STRUCTURAL STEEL FOR SUPPORTS

A. Assume engineering responsibility for design of steel supports.

B. Design units and connections to satisfy requirements of applicable Building Codes.

C. Design units and connections capable of withstanding the following design loads as shown on structural drawings within limits and under conditions indicated:
1. Include effect from adjacent attached construction.
2. Wind pressure, and/or earthquake lateral forces.
3. Live Loads.
4. Dead load of unit plus superimposed loads.

D. Structural Steel for Supports:
1. Comply with ASTM A36.
2. Galvanize members installed in fan plenums or areas of high humidity or condensation, and outside.
3. Furnish other members with shop coat of rust inhibiting primer.
4. Shop fabricate for field assembly using bolts.
5. Minimize field welding.
6. Retouch primer after field welding.

PART 3 - EXECUTION

3.1 GENERAL

A. When changes in location of work are required, obtain approval of Architect before making change.
   1. Make changes at no extra cost.

B. Provide necessary offsets and crossovers in piping and ductwork, whether indicated or not.

C. Install piping and ductwork parallel to walls and vertically plumb.

D. Do not change indicated sizes without approval of Architect.

E. Electrical equipment:
   1. Maintain space above electrical equipment rooms and closets clear of ductwork and piping.
   2. Maintain space above panelboards, switchboards, motor control centers, or motor control panels clear of ductwork and piping.

F. In elevator machine rooms, install no piping except floor drains and fire protection piping that specifically serves the room.

G. Roof penetrations:
   1. Make penetrations through roofs prior to installation of roofing.
   2. For penetrations required after installation of roofing:
      a. In built up roofing (BUR), provide curbs, cants and counter flashings.
      b. In elastic sheet roofing (ESR), arrange and pay for flashing work by authorized roofer; provide counter flashings.
   3. Repair and replace roof construction which is damaged by this work in manner which will not nullify roof warranty.

3.2 LOCATING SERVICEABLE DEVICES

A. Install devices that may require adjustment or service maintenance, in accessible locations or provide flush-mounted access doors.
   1. Such devices include but are not limited to equipment, valves, filters, motors, drives, compressors, unions, traps, strainers, thermometers, gauges, switches, measurement devices, coils, detectors, dampers, sensors, monitors, backflow prevention devices, drains, floor sinks, cleanouts, test stations, signal devices, sprinkler heads, air vents, expansion joints, and system drains.
   2. Arrange piping, conduit, ducts, and related work to facilitate maintenance.
   3. Relocate items which interfere with access.

3.3 CUTTING AND PATCHING

A. Requesting openings in advance.
   1. Coordinate locations with work of other sections.

B. Avoid cutting, where possible, by setting sleeves or frames.

C. Before cutting of structural elements, obtain written approval of Structural Engineer.
   1. Use only approved methods.
   2. Neatly cut holes as approved by structural engineer to admit work.
   3. Do not weaken walls or floors; locate holes in concrete to avoid structural members.

D. Perform cutting, fitting, repairing, patching and finishing of work to permit installation of mechanical work.

E. Locate openings and sleeves to permit neat installation of piping, ductwork and equipment.

F. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.

2. Repair or replace fireproofing removed or damaged.

G. Remove and replace existing ceilings for mechanical work in existing areas.

H. See Section 01 73 29.

3.4 EXCAVATING AND BACKFILLING

A. Perform excavating and backfilling for work in accordance with Section 20 10 10.

3.5 INSTALLATION OF EQUIPMENT

A. Install equipment in accordance with manufacturer's recommendations and as specified.

B. Provide necessary anchoring devices and supports.
1. Use structural supports suitable for equipment, or as indicated.
2. Check loadings and dimensions of equipment with shop drawings.
3. Do not cut building structural members.
4. Provide equipment supports even though not detailed on architectural and structural drawings.

C. Equipment Bracing:
1. See Section 20 05 48.

D. Coordinate fit of equipment support with layouts indicated.
1. Where substitute equipment is used, revise indicated supports to fit.

E. Arrange for necessary openings to allow entry of equipment.
1. Where equipment cannot be installed as structure is being erected, provide and arrange for building in of boxes, sleeves or other devices to allow later installation.

F. Install rain hoods and metal counter flashings as indicated, and to make penetrations of mechanical work through walls and roofs water and weather tight.
1. Furnish clamps, waterproofing material and labor.
2. Where metal flashings are applied over concrete, paint concrete with 1/8 IN of mastic cement first.
3. Set flashing in mastic cement, watertight.

G. Provide concrete foundations (isolation pads) or housekeeping pads for mechanical equipment as follows unless indicated otherwise:
1. Install 4 IN high concrete housekeeping pads. Outside dimension of pad shall be at least 4 IN larger in all directions than base of equipment or 9 IN from center of anchor, whichever is greater.
2. Use 3,000 PSI concrete.
3. Reinforce with No.4 bars, 12 IN OC each way, with short No.4 dowels into floor at 24 IN OC each way.
4. Chamfer top edges 3/4 IN.
5. Make faces smooth.
6. Set anchor bolts for equipment.

3.6 INSTALLATION OF EQUIPMENT FURNISHED BY OWNER OR OTHER DIVISIONS

A. Receive, uncrate and set in place mechanical equipment furnished by Owner or other Divisions.

B. Remove, relocate and reinstall existing mechanical equipment to be reused.

C. Provide rough-in and final connections to equipment requiring mechanical services.
1. See schedules.
2. Obtain rough-in data from inspection of same for existing equipment.
3. Obtain rough-in data from final shop drawings for equipment furnished by Owner or other divisions.

D. Install loosely shipped fittings, valves, and other items furnished as integral part of equipment.

3.7 PAINTING

A. See Section 09 91 13 and Section 09 91 23.

3.8 WORK IN EXISTING BUILDING

A. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work for minimal down time during slack periods.

B. Assign an adequate crew to accomplish job in shortest time.

C. Fabricate and install interconnecting portions of these systems prior to shut down for final connections including valve assemblies in piping systems and dampers in ductwork.

D. Locate existing piping and make connections as required.
   1. Do not cut into existing services without first verifying with Owner that service has been correctly identified.
   2. Perform work interrupting service at time to cause least interference to normal operation of building.
   3. Inform building engineering staff in advance of interruptions and provide estimate of duration.
   4. Begin work only after engineering staff is fully informed and has agreed to schedule of service interruptions.

E. Maintain existing services and equipment unless indicated to be removed.

F. Salvage items in accordance with Section 02 41 00.

3.9 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
   1. Conduct tests in presence of Architect and, if required, inspectors of agencies having jurisdiction.
   2. Arrange date of tests in advance with Architect, manufacturer and installer.
   3. Give inspectors minimum of 24 hour notice.
   4. Furnish or arrange for use of electrical energy, steam, water or gas required for tests.
   5. Furnish materials required for test.

B. Repair or replace equipment and systems found inoperative or defective and retest.
   1. If equipment or system fails retest, replace it with products conforming to Contract Documents.
   2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems for each item, unless otherwise recommended by manufacturer.
   1. Tests specified in Section 20 08 00, Testing and Balancing need not be duplicated under other sections.

3.10 ADJUST AND CLEAN

A. Inspect equipment and put in satisfactory working order.

B. Clean exposed and concealed items: See Section 01 74 00 Cleaning.
   1. Clean air surfaces of coils, fans (including fan wheels and motors), air handler plenums and air filter frames.
   2. Clean floor drains, cleanouts, and plumbing fixtures.
   3. Clean specialties such as traps and strainers and equipment surfaces such as pumps, motors, boilers, chillers, etc.
   4. Clean piping of tags, debris and other construction materials before insulating or painting.
   5. Clean debris including dirt and sand out of ductwork.

3.11 PUTTING SYSTEMS IN OPERATION - START UP

A. Prior to substantial completion and building occupancy, at time agreed to by Owner and Architect, put systems into satisfactory operation.
   1. At first heating or cooling season following substantial completion, put systems not yet operated under their seasonal loads into satisfactory operation.

B. Operate systems in satisfactory working order for period of 10 working days.
   1. After the 10 days, clean debris including dirt and sand out of ductwork.

END OF SECTION

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SECTION 20 05 05
MECHANICAL RENOVATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Scope of Work:
   1. Provide all labor and furnish all equipment necessary for the demolition of all Fire Protection, Plumbing, Mechanical Piping, Heating, Ventilating and Air Conditioning, and Controls for the work as specified and as indicated within the Contract Documents.
   2. The Contractor for each trade shall coordinate all work with other trades and the General Contractor.

1.2 RELATED DOCUMENTS

A. Work under this Section is subject to the requirements of the Contract Documents, including the Drawings, General and Supplementary Conditions, and the Specifications.
   1. Division 1: General Requirements.
   2. Work by Owner: Asbestos Abatement or Abatement of other hazardous materials.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. The Contractor and their Subcontractors shall only employ workmen who are skilled in their respective trades.

1.4 SUBMITTALS

A. Contract Initiation Information:
   1. Drainage piping video inspection report(s).
   2. Test, adjust and balance report(s).
   3. Air distribution duct cleaning qualifications and procedure(s).

1.5 PROJECT CONDITIONS

A. Existing conditions and demolition information shown on the drawings is based on a cursory field observation and any available record documents. Limited existing record documents may be available for contractor use and the accuracy of the record documents is unknown.

B. Perform all renovation work that may be required or necessary for a full and complete execution of the work, whether or not shown or specified. The exact extent of demolition and connection scope may not be as fully indicated by the drawings. The Contractor shall determine the exact nature and extent of the scope that will be necessary by comparing the contract documents with existing field conditions.

C. The beginning of demolition work means Contractor acknowledgement of the existing conditions.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Exercise care in transporting and handling removed materials to avoid damage to existing construction, fixtures and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials and equipment for patching, capping and sealing ductwork and piping as required and as indicated within the contract documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor shall visit and inspect the existing building and shall thoroughly familiarize themselves with the actual job conditions prior to submitting a proposal. Failure to do so shall not relieve the Contractor from performing the work required under this contract.

B. Notify the Architect/Engineer in writing of any conditions detrimental to the proper and timely completion of the demolition work. Do not proceed with the work until the unsatisfactory conditions have been corrected or properly addressed.

C. Prior to the removal of existing walls, verify the existing conditions, check to make sure that no existing piping, ductwork, conduit, etc., which the Architect/Engineer is unaware of, will be damaged. Rerouting of existing live services will be subject to the approval of the Architect/Engineer. Make arrangements with the Building Owner for the outages required of any services.

D. Verify that piping, ductwork and equipment being abandoned serves only the abandoned facilities area.

E. Prior to disconnection and removal of plumbing drainage piping, video inspect all existing drain lines that are intended to remain in service to ensure they are free of debris and in condition for reuse. Submit report to Architect/Engineer in written, accurate detail.

3.2 PREPARATION

A. At the beginning of construction, the Contractor shall seal the existing ductwork serving the areas of new work to reduce dust contamination to the building's system.

B. The Contractor shall be responsible to maintain the existing building operation in surrounding areas, at all times during the entire demolition period. If it is absolutely necessary to shut down part of or an entire system at any time, this Contractor shall consult with the General Contractor and Building Owner to make arrangements to do so at the Building Owner's convenience. The Contractor shall give a minimum of 7 day notice before shutting down the system and obtaining Building Owner's written authorization. Minimize outage duration during shutdown.

C. The Contractor shall maintain temporary ventilation for all areas of work in accordance with OSHA and local codes.

3.3 DEMOLITION WORK

A. Demolition work required in the building shall be performed in a manner and time acceptable to the Owner.

B. Disconnect and remove piping, ductwork, fixtures, trim, equipment, brackets, hangers, devices, and other accessories which are rendered obsolete or abandoned by this or previous alterations.

C. All piping of ductwork to be removed shall be removed back to the active source or valve and capped leaving no dead-end runs.

D. Perform cutting and patching required for the demolition work.

E. Materials and equipment to be salvaged or reused is identified on the Drawings. Salvaged items are the property of the Owner and shall be returned to the Building Owner's designated storage area. Care shall be taken during the handling of these items.

F. Demolished materials and equipment not being salvaged or reused shall become the property of the Contractor and removed from the site and legally disposed of.

3.4 RENOVATION WORK

A. If unanticipated mechanical (i.e. fire protection), electrical (i.e. conduit, cable tray) or structural elements intended to remain for reuse and which conflict with the systems involved in this work are encountered, investigate and measure both nature and extent of the conflict. Submit report to Architect/Engineer in written, accurate detail.

3.5 TESTING, ADJUSTING, AND BALANCING

A. Before demolition and after all openings in piping and ductwork have been capped (temporarily or permanently) as indicated on the drawings, this contractor shall employ the services of an independent "Testing, Adjusting and Balancing" professional to provide pre-read survey test, adjust and balance of all the existing-to-remain hydronic and air systems that are intended to be altered because of the demolition. These survey values shall be used to rebalance all the areas served by the systems involved in this work to the original set points.

B. It is the responsibility of this Contractor to make sure that all areas, served by the systems involved in this work, remain 100% operational and provided with the same comfort conditions as before.

C. Contractor shall submit the pre-read test, adjust and balance report(s) to the Architect/Engineer for approval.

3.6 CLEANING AND REPAIR

A. Maintain the spaces surrounding the area of work clean and clear of all demolition debris throughout the entire project duration.

B. After demolition, clean and repair the existing materials and equipment remaining in places that are to be reused.

C. Air Distribution Duct Cleaning:
1. Clean all the existing supply air, return air, and exhaust air duct systems, including all air outlets and inlets (diffusers, registers, and grilles), that are to be reused.
2. The Duct Cleaning Contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA) and shall also be a certified Air System Cleaning Specialist (ASCS).
3. The identified duct systems shall be cleaned in strict accordance with NADCA General Specification for the Cleaning & Restoration of Commercial HVAC Systems, Part 1 and Part 2.

END OF SECTION

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SECTION 20 05 10
ACCESS PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Access Panels, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

A. Project Information:
   1. Manufacturer of listed products.

B. Product Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Access Panels:
   1. Base:
      a. Milcor.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Sizes: 18 IN x 18 IN minimum; as indicated; or as required to allow inspection of items served.

B. Wall access panel: Type 3, fire rated masonry or concrete wall.
   1. Frame 16 GA, panel 20 gauge insulated.
   2. Continuous hinge with stainless steel pin.
   3. Self latching, automatic closing mechanism, inside release.
   4. Key operated cylinder lock with 2 keys.
   5. Factory attached masonry anchors for masonry, 1/2 IN x 4 IN studs for concrete, two per side.
   6. Baked enamel prime coat over phosphate coated steel.
   7. 1.5 HR fire rated.

C. Ceiling access panel: Type 4, plaster ceiling.
   1. Frame 16 GA, panel 14 GA, 22 GA casing bead.
   2. Two concealed spring loaded hinges allowing panel to open 175 degrees.
   3. Two screwdriver operated cam locks and two key operated cylinder locks, two keys.
   4. 3-1/8 IN wide expansion casing bead, 1-1/4 IN ground.
   5. Finish: Cleaned, rust inhibitive treated, baked prime paint.

D. Ceiling access panel: Type 5.
   1. Frame 16 GA offset panel 18 GA, recessed 1.5 IN to receive ceiling materials.
   2. Continuous hinge with stainless steel pin.
   3. One screwdriver operated cam lock and one key operated cylinder lock, two keys, protective plastic sleeve and grommet.
   4. Prime coat rust inhibitive white paint.
   5. Fire resistive.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions where work is to be installed.

B. Report unsatisfactory conditions.

C. Do not start work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Install as indicated on Drawings and where else required. Coordinate locations in field with Architect.

C. Install fire-rated access panels within fire-rated walls/ceiling, to match the fire rating.

END OF SECTION

SECTION 20 05 19
PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Piping Specialties, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Pressure gauges.
2. System drains.
3. Thermometer wells and test gauge connections.
4. Thermometers.
5. Wye strainers for steam and hydronic systems.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with applicable UL, ANSI and ASTM Standards.

1.3 SUBMITTALS

A. Shop Drawings:
1. Layout of piping showing expansion joints and manufacturer recommended locations for pipe anchor and guide locations.
2. Include axial, lateral, and vertical stresses at anchors as calculated by expansion joint manufacturer. Stresses shall be compliant with ASME B31.1 requirements.

B. Product Data:
1. Pressure gauges.
2. Thermometers.
3. Wye strainers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pressure gauges:
1. Base:
   a. Weiss Instruments.
2. Optional:
   a. Trerice, HO.
   b. Marsh Instrument.
   c. US Gauge.
   d. Weksler Instruments.
   e. Weston and Ernst.
   f. Winters.

B. Thermometers and Pressure Gauges:
1. Base:
   a. Weiss Instruments.

2. Optional:
   a. Marsh Instrument.
   b. Marshalltown Instrument.
   c. Palmer Instruments.
   d. Taylor Environmental Instruments.
   e. Trerice, HO.
   f. Weksler Instruments.
   g. Weston and Ernst.
   h. Ashcroft.
   i. Winters.

C. Wye strainers:
   1. Base:
      a. Armstrong International.
   2. Optional:
      a. Spirax Sarco.
      b. Keckley, OC.
      c. Metraflex.
      d. Mueller Steam Specialty.
      e. Spence Engineering.
      f. Victaulic of America.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 PRESSURE GAUGES

A. Pressure gauges:
   1. Steam systems and water systems operating above 150 DEGF:
      a. Case and twist ring: 4-1/2 IN diameter, anodized aluminum.
      b. Socket: Brass.
      c. Bourdon tube: Phosphor bronze.
      d. Movement: Bushed Brass Rotary.
      e. Dial: White aluminum, black markings.
      f. Pointer: Black or red anodized aluminum, slotted adjustable.
      g. Window: Glass.
      h. Siphon and gauge cock (low pressure steam): Brass.
      i. Siphon and needle valve (medium and high pressure steam): Brass.
      j. Accuracy: 1.0 % full scale, ASME B40.1 Grade 1A.
      k. Range: Operating pressure to occur in middle half (25 % to 75%) of the full scale range of the fluid being measured.
      l. Connections: 1/4 IN or 1/2 IN NPT.
   2. Compressed air systems and water systems operating below 150 DEGF
      a. Case and Ring: 4 IN diameter, liquid filled, type 304 stainless steel case with polished stainless steel bayonet ring.
      b. Fill liquid: Glycerin.
      c. Socket: Brass with push-in restrictor.
      d. Bourdon tube: Phosphor Bronze.
      e. Movement: Brass rotary type with bushings.
      f. Dial: White aluminum with black markings.
      g. Pointer: Black or red anodized aluminum, adjustable.
      h. Window: Clear acrylic.
      i. Snubber and gauge cock: Chrome plated brass.
      j. Accuracy: 1.0 % full scale, ASME B40.1 Grade 1A.
      k. Range:
         1) Refer to pressure range schedule except as follows:

a) Pump suction gauges for open piping systems where elevation difference between pump center line and liquid level of open system is less than 50 FT: Compound type, indicating at least 30 IN Hg to 30 PSIG.

l. Connections: 1/4 IN or 1/2 IN NPT.

3. Differential Pressure Gauges:
   a. Dial:
      1) Diameter: 4-1/2 IN.
      2) Face: White with black numerals and pointers.
      3) Body: Chrome plated brass.
      4) Seals: Teflon.
      5) Glass: Shatterproof.
   b. Piston Sensor.
   c. Accuracy: 2-1/2% over entire range.
   d. Range selection: Approximately 50% of full range.
   e. Accessories:
      1) Pulsation damper.
      2) Lever handle gauge cock.
4. Pressure gauge range schedule:

	Range PSIG	Fig. Interval PSIG	Inter. Gradu-ations PSIG	Bldg. Height Stories
Chilled/condenser water	0-60	5	1	to 4
Chilled/condenser water	0-100	10	1	over 4
Heating hot water	0-100	10	1	to 4
Heating hot water	0-160	20	2	over 4
Fire	0-400	50	5	
Cond. pump discharge	0-100	10	1	
LP Steam	0-60	5	1	
MP Steam	0-100	5	1	
HP Steam	0-300	25	5	
Flash tank	0-60	5	1	
Distilled water	0-60	5	1	
Compressed air	0-160	20	2	
Domestic hot water	0-200	20	2	
Domestic cold water	0-200	20	2	

2.3 SYSTEM DRAINS

A. Valved drains (nonpotable water):
   1. Piping 2 IN and smaller:
      a. 1/2 IN V-13, or V-14 with male hose-thread outlet and brass cap.
   2. Piping 2-1/2 IN and larger:
      a. 1-1/2 IN V-13 or V-14 ball valve with 1-1/2 IN fire hose adapter and cap.

B. Valved drains (potable water):
   a. 1/2 IN V-13 with plugged outlet.

C. On nonpotable systems, label system drains as nonpotable.

D. Valve standards: See Section 20 05 23.

2.4 THERMOMETER WELLS (SOCKETS) AND TEST GAUGE CONNECTIONS

A. Temperature sensing wells (sockets) and test gauge connections:
   1. Brass or stainless steel.
   2. Provide extension necks for insulated piping.

2.5 THERMOMETERS

A. BiMetal Thermometers:
1. Case: Type 304 Stainless Steel.
2. Window: Shatterproof glass or acrylic.
3. Stem assembly: Stainless steel all welded construction and 1/2 IN NPT connection.
4. Element fluid: Silicone.
5. Dial: Heavy gauge aluminum, white finish, black or red graduation lines and numerals.
6. Accuracy: 1.0 % of scale range.

B. Liquid filled thermometers:
1. Case: Industrial type molded polyester or die cast aluminum.
2. Window: Shatterproof glass or acrylic.
3. Liquid: Blue reading, non-mercury.
4. Scale: 9 IN scale minimum, black lines and numbers.
5. Accuracy: 1.0 % of scale range.
6. Angle adjustment: Variable with angle adjusting screw.

C. Thermometers range schedule:

	Range DEGF	Division DEGF
Domestic hot water	32-180	2
Domestic cold water	32-100	1
Heating hot water	50-300	2
Condensate pump disc	50-300	2
Compressed air	50-300	2
LP steam	50-300	2
Chilled water at coils	32-130	1
Chilled water at pumps and chiller	32-100	1

2.6 WYE STRAINERS FOR STEAM AND HYDRONIC SYSTEMS

A. Wye strainers.
1. Screwed or flanged.
2. Body:
   a. 2 IN and smaller:
      1) Cast bronze, ASTM B62, screwed ends.
   b. 2-1/2 IN and larger:
      1) Cast iron, flanged ends.
      2) Coating: Rust inhibiting.
3. Working pressure, non-shock: 150 PSIG.
4. Screens:
   a. Water: Bronze, monel or stainless steel.
      1) 2 IN and less: 3/64 IN perforations.
      2) 2-1/2 IN and larger: 1/8 IN perforations.
   b. Steam: Stainless steel or brass.
      1) 3/64 IN perforations.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties according to manufacturer instructions and as specified.

3.2 PRESSURE GAUGES

A. Install filter type pressure snubbers at pumps and chillers.

B. Install siphons on steam gauges.

C. Install brass tee handle cock and 1/4 IN hard tempered tubing from gauge to pipe connection.

D. Install additional brass tee handle cock at gauge for panel mounted gauge.

E. Calibrate and zero gauges at job site.

3.3 SYSTEM DRAINS

A. At low points of piping systems, provide valved drains to allow complete drainage of each system.

B. Neither terminate nor run drains over electrical equipment.

3.4 THERMOMETER WELLS AND TEST GAUGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

B. Placement and sizing:
   1. For 4 IN piping and larger, place tee in piping to create perpendicular flow-to-stem measurement.
      a. Size stem length based on pipe size as indicated below:
         1) 4 and 5 IN pipe: 3-1/2 IN stem.
         2) 6 and 8 IN pipe: 6 IN stem.
         3) 10 and 12 IN pipe: 9 IN stem.
         4) 14 IN pipe and larger: 12 IN stem.
   2. For piping smaller than 4 IN, place oversize piping well and tee in 90-degree piping turn to create parallel flow-to-stem measurement.
      a. Stem length: 12 IN.
      b. Piping well length: 14 IN.
      c. Size piping well and tee based on pipe size as indicated below:
         1) 1/2 and 3/4 IN pipe: 1-1/4 IN well and tee.
         2) 1 IN pipe: 1-1/2 IN well and tee.
         3) 1-1/4 and 1-1/2 IN pipe: 2 IN well and tee.
         4) 2 IN pipe: 2-1/2 IN well and tee.
         5) 2-1/2 and 3 IN pipe: 4 IN well and tee.

3.5 THERMOMETERS

A. Where temperature control requires a temperature transmitter, a thermometer is not required in same location unless specifically required in equipment specifications.

B. Where two or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.6 WYE STRAINERS

A. Provide wye strainers as indicated in piping-system sections.

B. Connections to suit piping system.

C. Provide blow-down valves:
   1. Strainers 6 IN and larger: 1-1/2 IN blow-down valve.
      a. Pipe blow down to drain.
   2. Strainers 2 to 5 IN: 1 IN blow-down valve with 3/4 IN hose end connection and brass cap.
   3. Strainers 1-1/2 IN and smaller: 1/2 IN blow-down valve with 3/4 IN hose end connection and brass cap.

END OF SECTION

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SECTION 20 05 23
MANUAL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Manual Valves, as indicated, in accordance with provisions of Contract Documents.

B. Definitions:
1. Class: ANSI Class.
2. SWP: Steam Working Pressure.
3. WOG: Water/Oil/Gas non-shock working pressure.
4. WWP: Cold water non-shock working pressure.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. This specification lists a variety of valves that may be applicable to the project. Not all valves listed are applicable to the project, refer to appropriate Sections for project applicability.

B. Boiler system valves: ASME Boiler Code Specifications.

C. Fire protection valves: UL listed, NFPA and FM approved.

D. Valves used in flammable liquid or flammable gas systems: UL listed for applicable service.

E. Valves cleaned for oxygen service: CGA Pamphlet G-4.1, Cleaning Equipment for Oxygen Service.

F. Valves for Potable Water: Shall comply with provisions called for by the Safe Drinking Water Act as amended by S3874 (the “Lead Free Law”) or any subsequent amendments or addendums thereto.

G. Valve bodies, shells and seats: Designed, manufactured, and tested in accordance with the following:
1. Pressure testing of steel valves: MSS SP-61.
2. Butterfly valves: MSS SP-67.
3. Cast iron gate valves, flanged and threaded ends: MSS SP-70.
4. Cast iron swing check valves, flanged and threaded ends: MSS SP-71.
5. Cast iron plug valves, flanged and threaded ends: MSS SP-78.
6. Bronze gate, globe, angle and check valves: MSS SP-80.
7. Valve pressure testing methods: MSS SP-82.
8. Cast iron globe and angle valves, flanged and threaded ends: MSS SP-85.
9. Diaphragm type valves: MSS SP-88.
10. Resilient seated eccentric cast iron plug valves: MSS SP-108.
11. Ball valves--threaded, socket-welding, solder joint, grooved, and flared ends: MSS SP-110.

H. Standard Specification for Composition of Bronze or Ounce Metal Castings: ASTM-B62.

I. Standard Specification for Steam or Valve Bronze Castings: ASTM-B61.

J. Iron body valves:
1. Pressure containing parts: ASTM-A126, Grade-B.
a. Standard Specification for Gray Iron Castings for valves, flanges and pipe fittings: ASTM-A126, Grade B.

2. Face to face and end to end dimensions: ANSI/ASME-B16.10.
3. Use domestic manufactured valves as defined by Buy American Act.

K. Valve stems: ASTM-B371, Alloy C69400; ASTM-B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

L. Indicate following information on valves:
1. Stamped or cast into body:
a. Manufacturer's name or trademark.
b. Pressure rating as Class, SWP, WOG, or WWP.
c. "UL-FM" for UL-FM valves.
2. Permanently attached to body:
a. Valve's country of origin.

1.3 SUBMITTALS

A. Product Data:
1. Valves.
a. In addition to submittal requirements of Section 01 33 00, submittal shall include the following:
1) For submittals with model numbers not listed in this section, include published cross reference sheet. Indicate association between submitted model number and the listed model number on the cross reference sheet.
2) For each valve submitted indicate in which specification section(s) and in which system(s) the valve will be used.
b. When valve assembly includes components other than the base valve body and handle (e.g., operator, valve box), include data on entire valve assembly.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Angle valves:
1. Base:
a. Nibco.
b. Stockham.
2. Optional:
a. Crane Valves.
b. Hammond Valve.
c. Jenkins Valves.
d. Lunken.
e. Milwaukee Valve.
f. Powell.
g. Walworth.

B. Ball valves:
1. Base:
a. Milwaukee Valve.
b. Nibco.
2. Optional:
a. Apollo.
b. Crane Valves.
c. Hammond Valve.
d. Jamesbury.
e. Jenkins Valves.
f. Stockham.

C. Butterfly valves:
   1. Base:
      a. DeZurik.
      b. Milwaukee Valve.
      c. Stockham.
      d. Victaulic of America.
   2. Optional:
      a. CenterLine Inds.
      b. Crane Valves.
      c. Jamesbury.
      d. Hammond Valve.
      e. Keystone Valve.
      f. Lunken.
      g. Mueller Steam Specialty.
      h. Nibco.
      i. Powell.
      j. Walworth.

D. High Performance Butterfly valves:
   1. Base:
      a. Dezurik.
   2. Optional:
      a. Bray Controls.
      b. Neles (Jamesbury).

E. Check valves:
   1. Base:
      a. Apco Valve & Primer.
      b. Nibco.
      c. Stockham Valves & Fittings.
   2. Optional:
      a. Crane Valves.
      b. Hammond Valve.
      c. Kennedy Valve.
      d. Milwaukee Valve.
      e. Mueller Steam Specialty.
      f. Powell.
      g. Victaulic of America.
      h. Viking.
      i. Walworth.
      j. Waterous.

F. Diaphragm valves:
   1. Base:
      a. Engineered Valves, ITT.
   2. Optional:
      a. Barnsted.
      b. Saunders Valve.

G. Gate valves:
   1. Base:
      a. Mueller Steam Specialty.
      b. Nibco.
      c. Stockham.
   2. Optional:
      a. Crane Valves.
      b. Hammond Valve.

c. Jenkins Valves.
d. Kennedy Valve.
e. Milwaukee Valve.
f. Powell.
g. Walworth.

H. Globe valves:
1. Base:
a. Stockham.
2. Optional:
a. Crane Valves.
b. Hammond Valve.
c. Jenkins Valves.
d. Lunken.
e. Milwaukee Valve.
f. Nibco.
g. Powell.
h. Walworth.

I. Plug valves:
1. Base:
a. DeZurik.
b. Resun Valves.
2. Optional:
a. Milliken.
b. Mueller Steam Specialty.
c. Rockwell International.
d. Victaulic of America.

J. Valve boxes and stop boxes:
1. Base:
a. Tyler Pipe.
b. Western.
2. Optional:
a. Neenah Foundry.
b. Vulcan.
c. Local foundry.

K. Balancing valves (globe style):
1. Base:
a. Tour and Anderson.
2. Optional:
a. Armstrong.
b. Wheatley.
c. Mepco.

L. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Ball valves:
1. Port size: Full port.
2. Ball and stem material: 316 Stainless Steel unless noted otherwise in specific valve description.
3. Blow-out proof stems.
4. Reinforced Teflon (RTFE) seats.
5. Teflon (PTFE) seals.
6. Adjustable packing.

7. 3-piece valves:
   a. Repairable in line.

B. Butterfly valves:
1. 90-degree operation.
2. Bubble-tight shut off, suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
3. 2 IN extended neck.
4. Lugs, where specified, shall be drilled and tapped.
5. Operators:
   a. 2-1/2 to 4 IN: Position lock handle.
   b. 5 IN and larger: Gear operator with 4-arm or wheel handle.
6. Bronze:
   a. Viton seals.
   b. Pressure rating: Refer to valve listings under Part 2.3.

C. High performance butterfly valves:
1. 90-degree operation.
2. Bi-directional, drip-tight shut off at full pressure rating.
3. 2 IN extended neck.
4. Lugs shall be drilled and tapped.
5. Operator: Gear type with 4-arm or wheel handle.
6. Body: Carbon steel.
7. Disc: Stainless steel.
8. Seat: RTFE.
9. Stem: Stainless steel; blow-out proof.
10. Taper pins: Compression type; stainless steel.
11. ANSI Class: 150.
12. Applicable fire test standard: API-607.

D. Chain operators:
1. Provide operators for valves located in mechanical spaces 8 FT or higher above floor.
2. Chain lever or chain sprocket operator with sufficient chain to reach within 5 FT of floor.
3. Remote operator accessories by same manufacturer as valve.
4. Do not provide for Fire Protection valves.

E. End styles, general:
1. Compatible with piping systems served.
2. Flanged valves:
   a. Class 125 cast iron: Flat flanges.
   b. Class 250 cast iron: Raised flanges.
   c. Ductile iron: Raised flanges.
3. Valves with solder ends for use in brazed piping systems shall be constructed for brazing.

F. Extended necks and stems:
1. For valves specified with extended necks or stems, provide design that isolates moving valve parts from insulation.
2. For valves specified with extended necks or stems and memory stops, provide design that allows access to memory stop without disturbing insulation.

G. Packing shall not contain asbestos.

H. Plug valves:
1. Eccentric plugs:
   a. Non-lubricated valves with resilient seats shall be suitable for 250 DEGF service.
   b. Rubber seated eccentric plugs: Bolted stem seals shall permit replacement of packing without removing valve from line or removing parts other than operator.

2.3 VALVES

A. General:
   1. Example model numbers may indicate a general series, or may be abbreviated. They may not reflect all features described. Provide valves with described features.
   2. Specified requirements are minimums. Valves that meet or exceed specifications may be submitted.
   3. Where valves are installed in piping systems using ring seal crimped pipe joining systems acceptable manufactures who manufacture valves designed for connection to ring seal crimped systems are acceptable. Refer to Section 22 10 16 Plumbing Piping and Section 23 21 13 Hydronic Piping Systems for acceptable applications of Ring Seal Crimped piping systems.

B. V-1: Gate valve, Class 125, bronze body, screwed bonnet, non-rising stem, solid wedge disc, solder. Example: Stockham B-112.

C. V-2: Gate valve, Class 150, bronze body, union bonnet, rising stem, solid wedge disc, threaded. Example: Stockham B-120.

D. V-3: Gate valve, Class 125, cast iron body, bronze trim, bolted bonnet, rising stem, OS&Y, solid wedge disc, flanged. Example: Stockham G-623.

E. V-4: Gate valve, same as V-2 except Class 200. Example: Stockham B-135.

F. V-5: Gate valve, same as V-3 except Class 250. Example: Stockham F-667.

G. V-6: Globe valve, Class 150, bronze body, union bonnet, renewable Teflon (PTFE) disc, solder. Example: Stockham B-24T.

H. V-7: Globe valve, same as V-6 except threaded. Example: Stockham B-22T.

I. V-8: Globe valve, Class 125, cast iron body, bronze trim, bolted bonnet, OS&Y, renewable seat and bronze disc, flanged. Example: Stockham G-512.

J. V-9: Globe valve, Class 200, bronze body, union bonnet, renewable plug type seat and disc, threaded. Example: Stockham B-62.

K. V-10: Globe valve, same as V-8 except Class 250. Example: Stockham F-532.

L. V-11: Ball valve, 150 PSI SWP, 400 PSI WOG bronze body, adjustable memory stop, 3-piece construction, extended stem, solder. Example: Milwaukee UPBA-350S.

M. V-12: Ball valve, same as V-11 except threaded. Example: Milwaukee UPBA-300S.

N. V-13: Ball valve, 150 PSI SWP, 400 PSI WOG bronze body, 2-piece construction, extended stem, solder. Example: Milwaukee BA-450S.

O. V-14: Ball valve, same as V-13 except threaded. Example: Milwaukee BA-400S.

P. V-15: Ball valve, 150 PSI SWP, 600 PSI WOG, 29 IN Hg vacuum service, full port, bronze body, 3-piece construction, chrome plated brass ball, Teflon seats, cleaned and capped for oxygen service, lockable or non-lockable as specified, color coded handle to match gas service, braze. Example: Milwaukee BA-350.

Q. V-16: Ball valve, 150 PSI SWP, 600 PSI WOG, 250 PSI UL listed for flammable liquids and LP gas, bronze body, 2-piece construction, standard or full port, bronze ball, non-lubricated, threaded. Example: Nibco T-580-70-UL & T-585-70-UL.

R. V-17: Angle valve, Class 125, bronze body, screwed bonnet, bronze disc, threaded. Example: Stockham B-216.

S. V-18: Angle valve, Class 125, cast iron body, bolted bonnet, bronze trim, renewable seat and disc, flanged. Example: Nibco F-818-B.

T. V-19: Angle valve, Class 200, bronze body, union bonnet, bronze disc, threaded. Example: Stockham B-237.

U. V-20: Angle valve, Class 250, cast iron body, bronze trim, flanged. Example: Stockham F-541.

V. V-21: Angle valve, automatic stop-check, Class 250, cast iron body, bolted bonnet, renewable disc and seat, flanged. Example: Stockham F-541.

W. V-22: Check valve, in-line pattern, spring-operated double doors, Class 250, cast iron body, renewable bronze doors and Viton-A seal, Inconel springs, stainless steel trim, flat faced wafer. Example: Stockham WG-976.

X. V-23: Check valve, Y-pattern, horizontal swing, Class 150, bronze body, threaded cap, renewable Teflon (PTFE) disc and seat, threaded. Example: Nibco T-433-Y.

Y. V-24: Check valve, Y-pattern, horizontal swing, Class 125, bronze body, threaded cap, renewable bronze disc and seat, solder. Example: Nibco S-413-Y-LF.

Z. V-25: Check valve, same as V-23 except Class 125. Example: Nibco T-413-Y-LF.

AA. V-26: Check valve, in-line pattern, spring-operated disc, Class 125, bronze body, renewable Teflon (PTFE) disc and seat, 316 stainless-steel spring, threaded. Example: Nibco T-480-Y.

BB. V-27: Check valve, T-pattern, horizontal lift, Class 150, bronze body, union bonnet, renewable Teflon (PTFE) disc and seat, threaded. Example: Stockham B-322-T.

CC. V-28: Check valve, T-pattern, horizontal swing, Class 125, cast iron body, bolted bonnet, bronze trim, renewable bronze or cast iron disc and seat, flanged. Example: Stockham G-931.

DD. V-29: Check valve, in-line pattern, spring-operated double doors, Class 125 (cast iron body) or Class 150 (steel body), Buna-N or EPDM seal, aluminum bronze or stainless steel doors, 316 stainless steel spring; grooved, threaded, flanged, wafer, or lugged at locations other than equipment; grooved, flanged or lugged if between equipment and its isolation valve. Example: APCO L9000.

EE. V-30: Check valve, silent, in-line pattern, spring-operated disc, Class 125, cast iron body, renewable bronze disc and seat, stainless steel spring, flat faced wafer. Example: Nibco W-910-B.

FF. V-31: Check valve, same as V-23 except Class 200. Example: Nibco T-473-Y.

GG. V-32: Check valve, same as V-28 except Class 250. Example: Stockham F-947.

HH. V-33: Butterfly valve, 200 PSI WWP; 27 IN Hg vacuum; cast or ductile iron body; EPT (EPDM) sleeve; stainless steel stem; aluminum-bronze or stainless steel disc; lugged. Example: Stockham L#-7#2.

II. V-34: Butterfly valve, same as V-33 except wafer. Example: Stockham L#-5#2.

JJ. V-35: Butterfly valve, 200 PSI WWP for 12 IN and smaller, 175 PSI WWP for 14 IN and larger; 27 IN Hg vacuum for all sizes; cast or ductile iron body; EPT (EPDM) seat; stainless steel stem; replaceable forged brass, aluminum-bronze, stainless steel, or EPDM coated ductile iron disc; grooved. Example: Victaulic 300/709.

KK. V-36: Eccentric plug valve, 175 PSI WOG, cast-iron body, bronze or nickel-plated cast-iron plug, Isobutene-Isoprene steam and plug seals, high-temperature plug face, capped drip tap on seat end of valve, memory stop, lever handle, threaded. Example: DeZurik 499S.

LL. V-37: Eccentric plug valve, 1205 kPa 175 PSI WWP for DN300 12 IN and smaller, 1035 kPa 150 PSI WWP for DN350 14 IN and larger, cast-iron body, Viton filled TFE U-ring seal, Isobutene-Isoprene plug face, memory stop; lever handle for sizes DN65 to DN100 2-1/2 to 4

IN; gear operator with handwheel actuator for sizes DN150 6 IN and larger; flanged. Example: DeZurik 118F.

MM. V-38: Eccentric plug valve, same as V-36 except flanged, or grooved. Example: DeZurik 499.

NN. V-39: Ball valve, same as V-13 and V-14 except include adjustable memory stop. Example: Milwaukee BA-100S and BA-150S.

OO. V-40: Butterfly valve, 200 PSI WWP, bronze body, adjustable memory stop with visual disc position range of 90 degrees, stainless steel disc and stem, Viton seal, threaded. Example: Milwaukee BB2-100.

PP. V-41: Plug valve, lubricated, 200 PSI WOG, semi-steel, bottom or bolted-top entry, UL listed for application, lubricant compatible with application, short pattern flanged. Example: Resun R-1431.

QQ. V-42: Not used.

RR. V-43: Diaphragm valve, weir style; unlined, 316 stainless steel body; 145 PSI at 120 DEGF for 4 IN and smaller, 125 PSI at 120 DEGF for 6 IN; 100 PSI at 120 DEGF for 8 IN; 65 PSI at 120 DEGF for 10 IN and larger; FDA PTFE diaphragm; Stainless steel bonnet with indicating travel stop; handwheel operated; threaded for 2 IN and smaller, flanged for 2-1/2 IN and larger. Examples: ITT 2403 and 2433.

SS. V-44: Diaphragm valve, weir style; solid PVC body; 150 PSI at 80 DEGF; FDA butyl rubber diaphragm; solvent weld socket. Example: ITT 2451.

TT. V-45, Gate valve with stop box:
1. Gate valve, inverted key, integral drain, 3/4 to 1 IN, threaded. Example Mueller H-15210.
2. Stop box, coated cast-iron, adjustable, cast-in marking indicating service. Example: Western 100.

UU. V-46, Gate valve with stop box:
1. Gate valve, curb stop, integral drain, 1-1/2 to 2 IN, threaded. Example: Mueller 15214.
2. Stop box, coated cast-iron, adjustable, cast-in marking indicating service. Example: Western 100.

VV. V-47, Gate valve with valve box:
1. Gate valve, AWWA-C500, 200 PSI WWP for 12 IN and smaller, 150 PSI for 14 IN and larger, iron body, bronze mounted, bronze or cast-iron double disc, non-rising stem, parallel seat, mechanical joint. Example: Stockham G-743.
2. Valve box: Coated cast-iron, 5-1/4 IN shaft, screw type, 3-piece, drop-in lid with cast-in marking indicating service. Example: Tyler 6860.

WW. V-48, Butterfly valve with valve box:
1. Butterfly valve, AWWA-C504, Class 150, iron body, stainless steel seat, aluminum-bronze or cast iron disc, natural rubber or Buna-N seat, mechanical joint or flanged. Example: DeZurik BAW.
2. Valve box: Coated cast-iron, 5-1/4 IN shaft, screw type, 3-piece, drop-in lid with cast-in marking indicating service. Example: Tyler 6860.

XX. V-49: Gate valve, UL-FM, 1205 kPa 175 PSI WWP, bronze body, union or screwed bonnet, solid wedge disc, OS&Y, threaded. Example: Nibco T-104-O.

YY. V-50: Gate valve, UL-FM, 1205 kPa 175 PSI WWP, cast iron body, bolted bonnet, resilient or solid wedge, OS&Y, flanged. Example: Stockham G-634.

ZZ. V-51: Butterfly valve, UL-FM, 1205 kPa 175 PSI WWP, ductile iron body, O-Ring seals, aluminum-bronze or ductile-iron disc, stainless steel stem, Buna-N seal, manual geared operator with visual position indicator, lugged. Example: Stockham LD-72UF.

AAA. V-52: Gate valve, UL-FM, AWWA C-509, 1205 kPa 175 PSI WWP, cast iron body, resilient wedge, non-rise stem, indicator post flange, MJ or flanged. Example: Stockham G-600/601/602.

BBB. V-53: Check valve, T-pattern, horizontal swing, UL-FM, 175 PSI WWP, cast iron body, bolted bonnet, bronze trim, renewable bronze or cast-iron disc and seat, flanged. Example: Stockham G-939.

CCC. V-54: Check valve, in-line, spring-operated single or double door(s), UL-FM, 200 PSI WWP, cast iron body, renewable bronze door and rubber or EPDM seat, stainless steel spring, wafer or grooved. Example: Stockham WG-990.

DDD. V-55: Butterfly valve, UL listed, 175 PSI WWP, bronze body, stainless steel stem and disc, Viton seal, threaded. Example: Milwaukee BB2-100.

EEE. V-56: Butterfly valve, same as V-40 except include extended neck, solder. Example: Milwaukee BB2-350.

FFF. V-57: Butterfly valve, same as V-40 except include extended neck, threaded. Example: Milwaukee BB2-100.

GGG. V-58: Not used.

HHH. V-59: Butterfly valve, same as V-55 with tamper switch. Example: Milwaukee BB2-100.

III. V-60: Plug valve, lubricated, 125 PSI WOG semi-steel, bottom or bolted-top entry, UL listed for application, lubricant compatible with application, threaded. Example: Resun R-1430.

JJJ. V-61: Butterfly valve, UL-FM, 175 PSI WWP, coated cast or ductile iron body, aluminum bronze or ductile iron disk with EPDM coating, manual geared operator with visual position indicator, grooved. Example: Victaulic 708.

KKK. V-62: Butterfly valve, 300 PSI WOG, 27 IN vacuum, brass body, aluminum bronze disk, extended neck, grooved. Example: Victaulic 608N.

LLL. V-63: High performance butterfly valve, Class 150, carbon steel body, RTFE seat, stainless steel shaft, stainless steel disc, TFE packing, wafer. Example: Dezurik BHP.

MMM. V-64: Globe-style balancing valve, Y-pattern design, rated for 300 PSI WWP and 250 DEGF, cast copper alloy construction, dual pressure/temperature read-out ports, calibrated handwheel with minimum (4) 360 degree adjustment turns and hidden tamper-proof memory stop, threaded or sweat connections and suitable for positive shut-off. Example: Tour and Andersson STAD/STAS.

NNN. V-65: Globe style balancing valve, Y-pattern design, rated for 250 PSI WWP and 250 DEGF, cast iron body fitted with copper alloy components, dual pressure/temperature read-out ports, calibrated handwheel with minimum (5) 360 degree adjustment turns and hidden tamper-proof memory stop, Class 125 flanged or grooved connections, and suitable for positive shut-off. Example: Tour and Andersson STAF/STAG.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to individual sections for specific valve installation requirements.

B. Keep valves clear of pull spaces.

C. Install valves in accessible locations for operation, removal, inspection, and repair of valves and equipment.

D. Install gate and globe valves with stem in vertical upright to horizontal position.

E. Install butterfly valves with stem in horizontal position.

F. Install diaphragm valves to be self draining.

G. Support valves individually to relieve pipe stress and allow equipment removal.

H. Follow manufacturer's recommendation for disassembly of valves for end joining method employed.

I. Provide globe valve in bypass around control valves. Coordinate with Controls Contractor.

J. Provide shut off valve on each side of control valve. Coordinate with Controls Contractor.

END OF SECTION

SECTION 20 05 29
PENETRATIONS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Penetrations and Supports, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Penetrations.
2. Pipe hangers and supports.
3. Pipe and equipment anchors.
4. Seismic bracing: Refer to Section 20 05 48.

C. Definitions:
1. UCSS: Universal Channel Strut System.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Pipe hanger standards:
1. Manufacturers Standardization Society (MSS) SP-58, SP-69, and SP-89, as referenced.
2. ASME/ANSI B31.1.

B. Seismic design criteria: See Section 20 05 48.

1.3 SUBMITTALS

A. Shop Drawings:
1. Layout for all required structural penetrations shown on structural framing plan or structural wall elevation. When working with existing construction include size and location of all existing penetrations on the drawing.
2. Pipe Racks:
   a. Detailed drawings and calculations, signed and sealed by a Specialty Structural Engineer.
3. Pipe Anchors:
   a. Detailed drawings, signed and sealed by a Specialty Structural Engineer.

B. Product Data:
1. Pipe hangers and supports:
   a. Identify each hanger according to systems, pipe sizes, and orientations on which it will be used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe hangers:
1. Base:
   a. PHD Manufacturing.
2. Optional:
   a. Anvil International.
   b. Cooper B-Line.

c. Tolco Inc.
d. Erico International.

B. Concrete inserts, post-pour:
1. Base:
a. Hilti.
2. Optional:
a. Simpson.
b. Powers Rawl.

C. Factory-fabricated supports for insulated pipe:
1. Base:
a. Pipe Shields.
2. Optional:
a. B-Line Systems.
b. Power Piping.

D. Freestanding roof supports:
1. Base:
a. PHP Systems.
2. Optional:
a. Miro Industries, Inc.
b. MIFAB, Inc.
c. Erico International.

E. Pipe and equipment anchors:
1. Base:
a. Shop fabricated.
2. Optional:
a. Field fabricated.

F. Factory-fabricated pipe supports at plumbing fixtures:
1. Base:
a. Sioux Chief Manufacturing.
2. Optional:
a. B-Line Systems.
b. Holdrite.
c. Sumner.

G. Universal channel strut system:
1. Base:
a. Unistrut (Tyco Electrical and Metal Products).
2. Optional:
a. Erico International.
b. Cooper B-Line.
c. Tolco, Inc.

H. Insulation Saddles:
1. Base:
a. PHD Manufacturing.
2. Optional:
a. Buckaroos, Inc.

I. Elastomeric Pipe Insulation Saddles:
1. Base:
a. Armacell engineered foams.

J. Seismic bracing systems: See Section 20 05 48.

K. Other manufacturers desiring approval comply with Section 01630.

2.2 PENETRATIONS

A. Penetrations - general:
1. For concrete walls, floors, roofs, foundations, footings and grade beams, provide openings sufficiently sized to allow free movement of piping with insulation continuous through sleeve.
2. Coordinate penetrations required with existing structural conditions. Obtain approval prior to coring as to avoid adversely affecting structural integrity.
3. Core drilling or cutting will not be permitted without prior written approval by structural engineer.
4. Opening diameters:
   a. Minimum 3 IN.
   b. Bare pipe: Minimum 1 IN larger than outside diameter of pipe.
   c. Insulated pipe: Minimum 1-1/2 IN larger than outside diameter of insulation.
   d. Diameter suitable for construction tolerances and to receive sealant.
5. Openings for future work: Same as this work.
6. Coordinate detailing of roof, foundation wall, and slab-on-grade penetrations with roofing, waterproofing, and vapor retarder installers. Protect continuity of roofing, waterproofing, and vapor retarder systems.

B. Pipe entrance wall sleeve and anchoring:
1. Provide steel, heavy wall welded or seamless pipe sleeve full circle continuously welded water stop plate.
2. Provide sleeve full length of wall thickness and protect with a primer coat.
3. Structurally secure pipe to withstand water hammer force.
   a. Extend exterior piping material into building a minimum of 12 IN.
   b. Provide a mechanical joint on interior end of pipe and mechanical tie in back to adjoining structural, exterior, wall.
4. Provide "Link-Seal" on pipe at exterior side of sleeve.

C. Sealants:
1. Seal annular space around piping.
2. Maintain fire and smoke ratings at pipe penetrations of fire and fire/smoke rated building elements. See Section 07 84 00.
3. For non-rated floors and walls see Section 07 92 16.
4. For exterior and foundation walls: Use synthetic rubber seals, "Link-Seal" water proof material or system.

2.3 PIPE HANGERS

A. Pipe hangers - General:
1. Materials, design and manufacture: MSS SP-58.
2. Fabrication and installation: MSS SP-89.
3. Selection and application: MSS SP-69.
4. Hangers and channels, angles, and supporting steel: Galvanized unless indicated otherwise.
5. Pipes running parallel may be supported on trapezes.
6. Hanger rods of continuous thread type: Galvanize after threads are cut.
7. Galvanize structural steel, angles, rods, channels, and hardware located in boiler, mechanical, and fan rooms and on roofs.
8. Where grooved couplings are used, place hanger within 2 FT each side of fittings or refer to manufacturer's pipe support and anchorage guide.
9. Screw threads on hangers and fittings: Conform to Class 2A and 2B of ANSI/ASME-B1.1.

B. Structural considerations:
1. Steel or concrete roof/floor system including slabs or roof deck shall be in place and complete before installation of mechanical piping system.

2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe hanger loading".
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers larger than 1/2 IN diameter to bottom of concrete filled floor or roof deck.
5. Individual hanger loads exceeding 1000 LB attached to the same deck span shall not be spaced closer than 5 FT on center.
6. The sum of all hangers supported by a slab span in a 5 FT by 5 FT area shall not exceed 1000 LB.
7. Attach hangers to beams whenever possible.

C. Pipe hanger spacing:
1. Locate hangers at each change of direction.
2. Space hangers at or within following maximum limits:

	Standard Steel		Copper	
Pipe Diameter	Fluid	Vapor	Fluid	Vapor
1/2 - 1 IN	7 FT	8 FT	5 FT	6 FT
1-1/4 - 2 IN	7 FT	9 FT	7 FT	9 FT
2-1/2 - 3 IN	11 FT	14 FT	9 FT	13 FT
3-1/2 - 4 IN	13 FT	16 FT	11 FT	15 FT
5 - 6 IN	16 FT	19 FT	13 FT	18 FT
8 - 14 IN	16 FT	24 FT	16 FT	23 FT
16 IN	12 FT	24 FT		

3. Fire protection piping: See Section 21 10 00.
4. For cast iron pressure piping, space maximum 12 FT on center.
   a. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.
5. For cast iron soil piping, space maximum 10 FT on center.
   a. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.
6. For piping materials not covered in this spec, space hangers according to manufacturer's recommendations.

D. Pipe hanger rod loading:
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 IN	560 LB
1/2 IN	890 LB
5/8 IN	1460 LB
3/4 IN	2030 LB

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

E. Pipe hangers for uninsulated pipe:
1. Independent hangers: MSS SP-69 type 1, 3, 4, 5, 7, 9, 10, 11, 12, 24, 41, 43, 44, 45, or 46.
   a. Types 7 and 10: Not allowed on pipe sizes greater than 6 IN.
2. Hangers used with trapezes:
   a. MSS SP-69 type 24 or 26.
   b. Hanger designed as part of UCSS.
3. Hangers supporting bare copper pipe:
   a. Copper plated or electro-galvanized hangers. Provide factory-applied felt or plastic padding to eliminate contact between support and copper pipe.

F. Pipe hangers for insulated pipe:
1. Hangers shall support piping from outside diameter of insulation.

2. Independent hangers: MSS SP-69 type 1, 3, 7, 9, 10, 41, 43, 44, 45, or 46.
   a. Types 7 and 10: Not allowed on pipe sizes greater than 6 IN.
3. Hangers used with trapezes:
   a. Pipe sizes 2 IN and smaller: MSS SP-69 type 26.
   b. Pipe sizes 2-1/2 IN and larger:
      1) MSS SP-69 type 24 or 26.
      2) Hanger designed as part of UCSS.
4. Pipe sizes 2 IN and smaller: Use hanger with insulation protection shield: MSS SP-69 type 40.
5. Pipe sizes 2-1/2 IN and larger: Use hanger with factory-fabricated support:
   a. 100 PSI, waterproofed calcium silicate fully encased in sheet metal shield.
      1) Pipe supported on rod hangers: Pipe Shields Models A1000, A2000, A3000, A4000 and A9000.
      2) Pipe supported on flat surfaces: Pipe Shields Models A1000, A2000, A5000, A6000 and A7000.
      3) Pipe supported on pipe rolls: Pipe Shields Models A3000, A4000, A5000, A6000 and A8000.
   b. Extend insulation inserts 1 IN beyond shields on refrigerant and chilled water lines.
6. For piping systems insulated with Elastomeric pipe insulation, composite Elastomeric and high density insert may be used:
   a. Jacket: 30 mils stainless steel.
   b. Basis: Armacell Armafix NPH pipe hanger inserts.
   c. Coordinate with Section 20 07 00 Pipe, Duct and Equipment Insulation for applicability.
7. Pipe sizes 2-1/2 IN and larger: Use hanger with field-fabricated support, which includes pipe covering protection saddle and insulation protection shield.
   a. Pipe covering protection saddle for steam systems, medium and high pressure condensate return systems, and systems with temperatures at or above 225 DEGF: MSS SP-69 type 39A or 39B in accordance with manufacturer's recommendations.
   b. Insulation protection shield: MSS SP-69 type 40.
   c. Within saddles, insert same type and thickness of insulation as adjoining pipe insulation.

G. Freestanding roof supports:
1. Support piping on roof with an engineered prefabricated supports designed for installation without roof penetrations, flashing or damage to the roofing material.
2. Base:
   a. Stainless steel, or injection molded high density / high impact polypropylene with UV-inhibitors and anti-oxidants.
   b. Provide base with foam pad.
   c. Provide base with swivel for slope adjustment.
3. Steel framing:
   a. Channel: Minimum 12 gage, 1-5/8 IN or 1-7/8 IN, as required for loading conditions.
   b. Finish: Hot dip galvanize in accordance with ASTM A123 after fabrication, free of roughness, unsightly spangles, droplets, and other surface blemishes.
4. Supports:
   a. Pipe sizes 2-1/2 IN and smaller: Adjustable height single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
   b. Pipe sizes 3 IN and larger: Adjustable height rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
   c. Finish: Hot-dip galvanized in accordance with ASTM A153.
5. Attachment when required for seismic application: No base mechanically attachment to roof deck.

H. Pipe hangers in other situations: See MSS-SP-69.

I. Trapezes:
1. Suspend trapezes from concrete inserts, approved structural clips or beam clamps.
2. Construct trapezes of galvanized angle iron, UCSS channels, or other structural shapes with flat surfaces for point of support.
3. See pipe hanger paragraphs for hanger types allowed with trapezes.

J. Vertical pipe supports and guides:
1. Support vertical pipe runs in pipe chases from the top and every other floor down.
2. Provide pipe guides for lateral movement on alternating floors of pipe supports.

K. Concrete inserts:
1. Post-pour concrete inserts:
a. Type: Drop-In wedging type tapped for threaded rods. At concrete slabs on steel deck, install anchor in top of deck flute.
b. Minimum embedment depth and base material thickness per anchor size shall be according to the following schedule:

Anchor Size IN	Minimum Base Material Thickness IN	Minimum Embedment Depth IN
1/4	3	1
3/8	3-1/8	1-9/16
1/2	4	2
5/8	5-1/8	2-9/16
3/4	6-3/8	3-3/16

L. Beam clamps:
1. Pipe size 3 IN and smaller:
a. MSS SP-69 types 19 or 23.
2. Pipe sizes larger than 3 IN but smaller than 8 IN:
a. Malleable-iron beam clamp: MSS SP-69 type 30.
b. Iron beam clamp: B-Line B3055 or equal.
3. Pipe sizes 8 IN and larger:
a. Forged steel beam clamps: MSS SP-69 type 28 or type 29.
b. Steel Beam clamps: B-Line B3291 through B3298 or equal.

2.4 PIPE RACKS

A. Assume engineering responsibility for design of steel rack.

B. Design racks and connections to satisfy requirements of applicable Building Codes.
1. Installation shall reflect the design intent of the drawings with respect to:
a. General pipe arrangement.
b. Pipe spacing.
c. Pipe clearances for access.
d. Rack structural arrangement.
e. Expansion anchor forces, when indicated.

C. Hangers attached to pipe racks: Same as for systems hung from building structural systems.

2.5 PIPE AND EQUIPMENT ANCHORS

A. Pipe Anchors:
1. Provide as indicated and required to permit complete installation of system.
2. Do not anchor piping to plaster or gypsum wallboard partition walls.
3. Provide anchoring devices at locations indicated.
4. General arrangement subject to review and approval of the Structural Engineer of Record.

5. Assume engineering responsibility for design of pipe anchors and connection of anchor to structure.
6. Design anchors to satisfy requirements of applicable Building Codes.
7. Design for stresses determined by expansion joint manufacturer. Adjust stresses at structure connection point for distance between anchor and structure connection point.
   a. See Section 20 05 19.
8. Coordinate with seismic design.
   a. See Section 20 05 48.

B. Anchors:
   1. Angle iron and rods with turnbuckles, unless detailed otherwise.

C. Anchors for ductwork, equipment and piping hanger rods:
   1. Post-pour concrete inserts: Hard-metal, self-drilling wedging anchors tapped for threaded rods and designed not to depend on lead or wood for holding power.

2.6 PIPE SUPPORTS AT PLUMBING FIXTURES

A. Pipe supports at plumbing fixtures:
   1. Factory-fabricated metal brackets.
      a. Plastic grommets/inserts factory fabricated for specific pipe diameters and materials.
   2. Factory-fabricated PVC pipe supports and pipe fasteners.
      a. Fastening method: Stainless-steel bands and screws.
      b. PVC: Fire retardant.

PART 3 - EXECUTION

3.1 GENERAL

A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

B. Provide complete and adequate support of all piping whether or not all required devices are shown.

3.2 PENETRATIONS

A. Coordinate locations of openings in structural systems with Architect.

B. Maintain fire and smoke ratings at pipe penetrations of fire and fire/smoke rated building elements.

C. Set sleeves plumb or level, in proper position, tightly fitted into work.
   1. Remove sleeves before installing piping.

3.3 PIPE HANGERS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate with project structural engineer proper placement of inserts, anchors and other building structural attachments.

C. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise. Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

3.4 PIPE SUPPORTS AT PLUMBING FIXTURES

A. Pipe supports at plumbing fixtures:
   1. General: Fasten piping to supports within 8 IN of final fixture connection point (valve).
   2. Factory-fabricated brackets:
      a. Fasten brackets to studs with screws.
      b. Galvanized brackets:
         1) Fasten piping to brackets with plastic grommets/inserts.
      c. Copper-clad brackets:
         1) Use only with copper piping.
         2) Isolate copper-clad brackets from metal studs with insulating tape, felt, or rubber pads.
         3) Fasten piping to brackets by soldering or by using plastic grommets/inserts.
   3. Factory-fabricated PVC supports:
      a. Fasten brackets to waste piping, fixture carriers, or studs.

END OF SECTION

SECTION 20 05 48
MECHANICAL SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Mechanical Seismic Restraint Systems, as indicated, in accordance with provisions of Contract Documents.

B. This specification covers design and installation of seismic bracing and anchorage required for piping, ductwork, and equipment. Contractor is responsible for design approval and installation of seismic bracing and anchorage systems.

C. Description of systems:
1. Transverse and longitudinal bracing for seismic forces on suspended mechanical systems including piping, ductwork, and equipment.
2. Anchorage of floor and roof mounted mechanical equipment.

D. Seismic bracing of vibration isolated equipment:
1. See Section 20 05 50.

E. Deferred approval items: Provide design and details of anchorages or restraints conforming to Title 24, Section T22-94215 Earthquake Regulations; prepared and signed by a Structural Engineer licensed in State of California.

F. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Seismic Design Requirements.
1. Seismic design criteria: Provide bracing and anchoring for equipment, piping, ductwork, stacks and breeching designed, constructed, and installed to resist stresses produced by lateral forces specified under the authority below:
   a. IBC 2012 year, for Seismic Design Category D.
   b. California Administrative Code, Title-22 and Title-24.
   c. Applicable local codes.

B. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LB or more and suspended or wall mounted equipment weighing 20 LB or more.

C. Following components are exempt from requirements of this Section:
1. Mechanical components in structures assigned to Seismic Design Category C provided that the importance factor (Ip) is equal to 1.0.
2. Mechanical components in Seismic Design Categories D, E, and F where Ip = 1.0 and flexible connections between the components and associated ductwork and piping are provided and that are mounted at 4 FT or less above a floor level and weigh 400 LB or less.
3. Mechanical components in Seismic Design Categories D, E, and F weighing 20 LB or less where Ip = 1.0 and flexible connections between the components and associated ductwork and piping are provided, or for distribution systems, weighing 5 LB/FT or less.

D. For this project, the following seismic coefficients shall be used in calculating the required lateral force:
1. S_{DS} = 1.00 IBC
2. Ip = 1.0

3. Ip= 1.0, except as noted below:
   a. Ip= 1.5, for all life safety and critical systems including:
      1) Fire protection.
      2) Fuel piping.
      3) Additional systems as defined by applicable codes.

E. All lateral forces shall be presumed to act through the components center of gravity

1.3 INSTALLATION INSPECTION

A. Certify that seismic bracing system installed is in accordance with approved shop drawings

B. Certifier qualifications:
   1. Pre-engineered systems: Qualified factory representative.
   2. Custom engineered systems: Design engineer as identified under submittal requirements.

1.4 SUBMITTALS

A. Design Drawings:
   1. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
   2. Reference specific detail for each type of brace or anchor identifying required locations.

B. Product Data:
   1. Technical data on seismic control devices.
   2. Certificate that seismic bracing system installed is in accordance with approved shop drawings

C. Project Information:
   1. Engineering calculations indicating design moments, shears, and other forces sealed by the Specialty Structural Engineer Submit concurrent with Shop Drawings.
   2. Deferred approval items: Provide design and details of anchorages or restraints conforming to Title 24, Section T22-94215 Earthquake Regulations; prepared and signed by a Structural Engineer licensed in State of California.
   3. Certificate that seismic bracing system installed is in accordance with approved shop drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mechanical Seismic Restraint Systems:
   1. Base:
      a. Mason Industries.
      b. International Seismic Application Technology (ISAT).
   2. Optional:
      a. Amber/Booth Company.
      b. Vibro-Acoustics.
      c. Vibration Mountings and Controls.

B. Other manufacturers desiring approval shall comply with Section 01630.

C. Custom engineered systems designed using specified criteria and common building materials.

2.2 MATERIAL

A. Equipment Anchors and Supports:
   1. Drilled-in-place concrete anchors shall have an approved ICC Evaluation Services Report.
   2. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554-36.

3. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.
4. Structural steel for supports: ASTM A36.
5. Cold formed metal and connection material: Unistrut or equal.

B. Details provided are based on assumed equipment and arrangement. Design and acquire approval for support and anchorage of equipment or arrangement which varies from detail provided.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Design and install bracing and anchoring for equipment, piping, ductwork, stacks and breeching in accordance with requirements of this specification

B. A run is defined as suspended pipe, duct or trapeze rack having a minimum 5 FT straight run length.

C. Every run which requires bracing shall have a minimum of two Transverse Braces and one Longitudinal Brace.

D. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

E. Bracing may be omitted from piping, ductwork, conduit, cable tray and bus duct runs less than 5 FT in length.

F. Except for sprinkler piping, bracing may be omitted from piping and ductwork runs where rod hung supports of less than 12 IN in length are required, subject to the following:
1. Unbraced suspended ductwork and other unbraced suspended utility systems are to be installed with a minimum 6 IN clearance to suspended ceiling vertical hanger wires.
2. Install piping or ductwork such that lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.
3. Supports are less than 12 IN for total run. Rod hung supports less than 12 IN shall not create moment forces on the hanger rod.

G. A longitudinal brace at a 90 degree change in direction may act as a transverse brace if it is located within 2 FT or two duct widths, whichever is greater, of the change in direction.

H. A Transverse brace may act as a longitudinal brace if it is located within 2 FT or 2 duct widths, whichever is greater, of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

I. When bracing equipment or a utility system suspended from an overhead deck, brace back to overhead deck or structure supporting the deck.

J. Do not brace to another element of the structure which may respond differently during a seismic event.

K. Obtain approval from Structural Engineer prior to attaching to any brace elements to structural steel or wood framing.

L. Tension cable to remove slack from cable bracing without inducing uplift of suspended element.
1. Tension seismic bracing system prior to equipment start up and adjust after start up.

M. Do not mix rigid bracing with cable bracing in same run unless approved by Structural Engineer.

N. Install brace members at an angle of 45 degrees from horizontal within a tolerance of plus 2 1/2 degrees or minus 45 degrees provided the brace length is accounted for in design. Brace angle

may be increased to 60 degrees provided the brace spacing is reduced to 1/2 that required for a 45 degree brace.

O. Seismic bracing may not pass through a building separation joint. Utility systems that pass through a separation joint must be seismically restrained within 5 FT of point of connection or any hardware designed to accommodate seismic movement across the span of the separation joint.

P. With approval of the Structural Engineer, utility systems within a basement that are suspended from the overhead deck may be braced to load bearing basement walls provided that the walls and the overhead decks will respond similarly during a seismic event.

Q. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

R. Pipes or ductwork constructed of non-ductile material (plastic, fiberglass, or no hub cast iron), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials. In addition, no hub cast iron piping shall be braced on either side of a horizontal 90 degree change in direction and when installed as a riser, shall include the use of a joint stabilizer where the joints are unsupported between floors.

S. Where brace elements are through-bolted, mounting hole in element is to be no more than 1/16 IN diameter larger than bolt or threaded rod.

T. Seismic braces shall directly brace system and not hanger.

3.2 SUSPENDED PLUMBING, MECHANICAL AND PROCESS PIPING

A. Install seismic bracing for pipe runs meeting the following parameters:
   1. Fuel, medical gas and medical vacuum piping with diameters equal to or greater than 1 IN.
   2. Other piping (regardless of use) with diameters equal to or greater than 2-1/2 IN.

B. Trapeze assemblies supporting pipes shall be braced considering the total weight of the elements on the trapeze computed as pounds per lineal feet.

C. Unless an individual element or trapeze would otherwise require bracing, brace trapezes with a minimum weight in excess of 10 LB per lineal foot.

D. For the purpose of calculating weight, piping is to be treated as full of water.

E. Locate seismic bracing no more than 10 FT from each main riser, at every piece of equipment, and at the entrance to the building.

F. Do not use branch lines to brace main lines.

G. At vertical pipe risers, wherever possible, support weight of riser at a point or points above center of gravity of riser.

H. Provide lateral guides at the top and bottom of the riser, and at intermediate points not exceeding 30 FT on center.

I. Bracing requirements and installation details for piping anchors and guides designed to accommodate thermal pipe movement are require custom analysis and design. Thermal pipe stress analysis and anchor /guide design shall be undertaken by a licensed engineer trained in thermal pipe stress analysis. Seismic forces and detail requirements as specified in this Section shall be included in the design of such anchors and guides.

J. Individually supported pipes on rollers or hangers suspended from dual threaded rods shall employ a top roller in contact with the top of the pipe to prevent uplift during a seismic event.

3.3 HVAC DUCTWORK AND SUSPENDED HVAC EQUIPMENT

A. Install seismic bracing on HVAC ducts meeting the following parameters:
   1. Rectangular air handling ducts equal to or greater than 6 square feet in cross sectional area.
   2. All round air-handling ducts with diameters equal to or greater than 28 IN.

B. Trapeze assemblies supporting ducts shall be braced considering the total weight of the ducts on the trapeze.

C. Brace in-line equipment rigidly mounted to duct independently of duct work if unit weighs 50 LB or more.
   1. If equipment is flexibly connected to the ductwork, independently brace equipment weighing 20 LB or more.
   2. Mechanical piping connections to the equipment are to be flexible.
   3. Nearest transverse brace for connected duct shall be at a distance away from equipment of no more than 1/2 transverse brace spacing required.

D. Vertical duct runs mechanically attached to floors at a point of penetration may be considered as a transverse and longitudinal brace location provided anchorages and duct framing accommodate engineered load and provided distance to nearest 90 degree change in direction is no more than two duct widths.

E. Install a transverse brace on either side of a horizontal, ninety degree change in duct direction and within 10 FT of the end of a duct run.

F. Vertical support rods are to be continuous from the lowest element of the duct or equipment support framing upward to the point of connection with anchorage to the structure. Rod couplers are permitted at the top of the rod for connection to deck anchorage.

3.4 FIRE PROTECTION PIPING

A. Install lateral, transverse, seismic bracing spaced no more than 40 FT on center on all feed and cross mains and branch lines and other piping 2-1/2 IN diameter and larger.

B. Install lateral, transverse, seismic bracing on last length of pipe and at end of a feed or cross main.
   1. Distance between end of pipe and last brace shall not exceed 20 FT.

C. Install longitudinal bracing maximum of 80 FT on center for feeds and cross mains

D. Omit seismic bracing at sprinkler piping suspended by individual hangers 6 IN or less in length from top of pipe to bottom of structural attachment for hanger provided hanger rods are constructed in such a manner as to not produce bending in rod or attachment.

E. For purpose of calculating weight, treat piping as full of water.

F. Seismically brace tops of vertical riser piping using four way bracing.

3.5 FLOOR OR ROOF MOUNTED EQUIPMENT

A. Provide one mounting device on each leg or support with minimum three 3/8 IN diameter anchors.
   1. Do not include friction when designing anchors for shear.

B. Seismic forces shall be presumed to act through center of mass of equipment in direction producing largest single anchor force.

C. Calculate vertical seismic forces to act concurrently with horizontal seismic forces.

END OF SECTION

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SECTION 20 05 50
MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Mechanical Sound and Vibration Control, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Vibration isolators.
2. Bases.
3. Piping connections.

C. Definitions:
1. Seismic bracing or restraint; devices used to keep vibration isolated components in place during a seismic event.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM and AASHO standards.

B. Seismic design criteria: Comply with Section 20 05 48.

1.3 SUBMITTALS

A. Shop Drawings:
1. Submit drawings for each piece of isolated equipment.
2. Include drawings of spring isolators with equipment submittal. Include the following information:
   a. Spring diameter.
   b. Deflection.
   c. Compressed spring height.
   d. Solid spring height.
   e. Point location of each isolator.
   f. Calculated load at each point.
   g. Field static deflection.
   h. Calculated horizontal loading and bolt requirements.
   i. Indicate base clearance of 1 IN.
   j. Installation instructions and drawings.
   k. Detailed drawings showing location of seismic restraints including static and dynamic loading for coordination with supporting structure.
   l. Specific details of seismic restraints and anchors including number, size and location for each piece of equipment.

B. Product Data:
1. Vibration isolators, bases, and piping connections for equipment: Include with equipment submittal.
2. Vibration isolators, bases, and piping connections for applications other than equipment.
   a. Indicate specific applications with submittal.
3. Seismic restraint calculations stamped and signed by a registered Engineer licensed to practice Structural Engineering in the state where the job is located. Restraint or bracing

devices shall have a pre-approval "OPA" number for California OSHPD or some other recognized government agency showing maximum restraint rating.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mechanical Sound and Vibration Control:
   1. Base:
      a. Mason Industries.
   2. Optional:
      a. Vibration Mountings and Controls.
      b. Vibration Eliminator.
      c. Korfund Dynamics.
      d. Amber/Booth.
      e. California Dynamics.
      f. Vibro-Acoustics.
      g. Kinetics Noise Control.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Provide piping and equipment isolation systems as specified.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.

C. Provide vibration isolation equipment including isolators, bases, and piping connections from a single manufacturer of vibration isolation equipment.

D. Coat vibration isolation systems exposed to moisture and an outdoor environment as follows:
   1. Hot dip galvanize steel parts.
   2. Coat springs with neoprene.
   3. Cadmium plate hardware.

2.3 VIBRATION ISOLATORS

A. Neoprene Isolators:
   1. Type 1 seismic isolator: Same as Type 2 seismic isolator.
   2. Type 2 seismic isolator:
      a. Similar to ASHRAE Type D snubber.
      b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.
      c. Resilient seismic capability in every direction.
      d. Ductile-iron casting containing two separated and opposing molded neoprene elements with center threaded sleeve and adjustment bolt.
      e. Neoprene elements shall prevent center sleeve from contacting casting during normal operation.
      f. Neoprene: Bridge bearing.
   3. Type 2 isolator for suspended supports:
      a. Molded neoprene, double-deflection.
      b. Similar to ASHRAE Type 2 isolation hanger.
      c. Provide color coded neoprene-stock elements for easy identification of rated load capacity.
         1) Provide integral extension bushing on element where it contacts hanger frame to prevent metal to metal contact between frame and hanger rod.
      d. Provide hanger for direct attachment to flat iron duct straps.

B. Spring Isolators:
   1. Type 3 seismic isolator:
      a. Similar to ASHRAE Type C snubber.
      b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.
      c. Free-standing, laterally stable spring isolator with ductile-iron housing and resilient snubbing collars.
      d. Provide acoustical neoprene separator between spring(s) and base plate to prevent short circuiting through baseplate anchor bolts.
      e. Resilient seismic capability in every direction.
         1) Snubbing shall occur in every direction with adjustment to limit upward, downward, and horizontal travel to a maximum of 1/4 IN.
      f. Provide leveling bolts for rigid attachment to equipment.
      g. Spring diameters: Not less than 0.8 of compressed height of spring at rated load.
      h. Minimum additional travel of spring to solid: 50 % of rated deflection.
      i. Provide ports in mounting for spring inspection.
   2. Type 3 seismic isolator:
      a. Provide one snubbing component for each resilient component.
         1) Use either Type A or Type B snubbers, but use only one type on any one piece of equipment.
      b. Resilient component:
         1) Similar to ASHRAE Type 3 spring isolator.
         2) Free standing and laterally stable without housings, snubbers or guides.
         3) Provide 1/4 IN neoprene acoustical friction pads between baseplate and support.
         4) Provide leveling bolts for rigid attachment to equipment.
         5) Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
         6) Spring shall have minimum additional travel to solid equal to 50 % of rated deflection.
      c. Type A snubbing component:
         1) Similar to ASHRAE Type A snubber.
         2) Snubber shall have Anchorage Preapproval "OPA" number from California OSHPD.
         3) Restrains seismic movements in every direction.
         4) Interlocking steel members restrained by a neoprene bushing.
         5) Neoprene bushing: Bridge bearing, replaceable, minimum of 1/4 IN thick.
         6) Provide a minimum 1/8 IN air gap between resilient and rigid components of snubber attached to structure and equipment, respectively.
         7) Provide removable end cap to allow inspection of internal clearances.
      d. Type B snubbing component:
         1) Similar to ASHRAE Type B snubber.
         2) Snubber shall have Anchorage Preapproval "OPA" number from California OSHPD.
         3) Restrains seismic movements in every direction.
         4) Interlocking steel members restrained by a neoprene bushing.
         5) Neoprene bushing: Bridge bearing, replaceable, minimum of 1/4 IN thick.
         6) Provide a minimum 3/16 IN air gap between resilient and rigid components of snubber attached structure and equipment, respectively.
         7) Provide with factory installed spacers that maintain designed clearances during installation.
   3. Type 3 isolator for suspended supports:
      a. Similar to ASHRAE Type 3 spring hanger.
      b. Provide Steel spring and neoprene cup element in series inside bottom of hanger frame.
         1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
      c. Provide integral extension bushing on neoprene element where it contacts hanger frame to prevent metal to metal contact between frame and hanger rod.

d. Minimum additional spring travel to solid: 50 % of rated deflection.
e. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.

4. Type 3N isolator for suspended supports:
   a. Similar to ASHRAE Type 3 spring hanger.
   b. Provide Steel spring and molded neoprene element in series inside bottom of hanger frame.
      1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Provide color coded neoprene-stock elements for easy identification of rated load capacity inside top of hanger frame.
   d. Provide integral extension bushing on neoprene elements where they contact hanger frame to prevent metal to metal contact between frame and hanger rod.
   e. Minimum additional spring travel to solid: 50 % of rated deflection.
   f. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.
5. Type 3P isolator for suspended supports:
   a. Similar to ASHRAE Type 3 spring hanger.
   b. Same as Type 3N except spring is precompressed to rated deflection so piping/equipment is maintained at a fixed elevation during installation.
   c. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
6. Type 4 seismic isolator:
   a. Similar to ASHRAE Type 4 restrained spring isolator.
   b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.
   c. Free-standing, laterally stable spring isolator.
   d. Provide resilient vertical limit restraints to prevent spring extension during weight changes.
      1) During normal operation, restraints shall not contact spring assembly.
   e. Provide acoustical neoprene separator between spring(s) and base plate to prevent short circuiting through baseplate anchor bolts.
   f. Installed height shall equal operating height.
   g. Provide Resilient seismic capability in every direction.
      1) Snubbing shall occur in all directions with adjustment to limit upward, downward, and horizontal travel to a maximum of 1/4 IN.
7. Type 5 thrust restraint:
   a. Similar to ASHRAE Type 5 thrust restraint.
   b. Same as Type 3 isolator for suspended supports except with angle-iron and rod attachments configured for mounting across flexible duct connection.

2.4 BASES

A. Bases:
   1. Type B, structural steel base:
      a. Rectangular in shape except for equipment which may require "T" or "L" shaped bases.
      b. Bases for split case pumps:
         1) Provide supports for suction and discharge base ells.
         2) Size base large enough to support base-ell supports.
      c. Perimeter members: Beams with a minimum depth equal to 0.10 of longest dimension of base.
      d. Beam depth need not exceed 14 IN provided that deflection and misalignment is kept within acceptable limits as determined by manufacturer.

e. Provide height saving brackets in mounting locations to provide a base clearance of 1 IN.

2. Type C, concrete-filled, structural steel base:
   a. Rectangular structural beam or channel concrete forms for floating foundations.
   b. Minimum base depth: 0.083 of longest dimension of base, but not less than 6 IN.
   c. Base depth need not exceed 12 IN unless specially recommended by base manufacturer for mass or rigidity.
   d. Bases for split case pumps:
      1) Provide supports for suction and discharge base ells.
      2) Size base large enough to support base-ell supports.
   e. Provide minimum concrete reinforcement consisting of 1/2 IN bars or angles welded in place on 6 IN centers running both ways in a layer 1-1/2 IN above bottom, or additional steel as is required by structural conditions.
   f. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
   g. Provide height saving brackets in mounting locations to maintain a 1 IN clearance below base.
3. Type D, curb mounted base:
   a. Factory assembled isolation base that fits over roof curb and under isolated equipment.
   b. Provide extruded aluminum top member to overlap bottom member to provide water run off independent of seal.
   c. Provide Type 3 isolators integral with base.
      1) Minimum deflection: 1.5 IN.
   d. Design shall allow springs to be inspected, serviced, and changed out while disturbing neither the roofing nor the unit.
   e. Provide resilient snubbers in corners with minimum clearance of 1/4 IN for wind resistance.
   f. Provide a weather seal of continuous closed cell sponge material both above and below base and a waterproof flexible duct-like EPDM connection joining outside perimeter of aluminum members.
   g. Foam or other contact seals are not acceptable at spring cavity closure.
4. Type IP, field assembled concrete base:
   a. Isolation bases:
      1) Field assembled concrete pads provided by Contractor.
      2) See Division 03 and structural drawings.

2.5 PIPING CONNECTIONS

A. Pipe Connections:
   1. Flexible pipe connectors (FPC):
      a. Flexible neoprene/EPDM:
         1) Straight connectors: Twin sphere type.
         2) Elbow connectors: Single sphere type.
      b. Multiple plys of friction nylon tire cord with EPDM cover and liner.
      c. Do not use steel wire or rings as pressure reinforcement.
      d. Connectors:
         1) 2 IN NPS and smaller: Threaded or flanged ends.
         2) 2-1/2 IN NPS and larger: Floating galvanized steel flanges.
      e. Minimum pressure ratings:
         1) Twin spheres: 250 PSI at 170 DEGF and 165 PSI at 250 DEGF.
         2) Elbows and reducing twin spheres: 220 PSI at 170 DEGF and 145 PSI at 250 DEGF.
   2. Flexible pipe hoses (FPH):
      a. Braided, stainless-steel type.
      b. Stainless steel braid: Type 321.

c. Fittings: Carbon steel.
d. Connections:
   1) 2-1/2 IN NPS and smaller: Male nipples or copper sweat to match specified piping joints.
   2) 3 IN NPS and larger: Flanged.
e. Minimum transverse motion: ± 3/8 IN with no permanent misalignment.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL

A. Install vibration control equipment in accordance with manufacturers installation instructions and as specified.

B. Select vibration control equipment as specified, and size in accordance with weight distribution, pull, and torque imposed by equipment being isolated.
   1. Base selection on equipment with Architect approved submittals.
   2. Minimum static deflections may be revised subject to prior approval.

C. Provide revised vibration control equipment to match revised or substituted equipment.

3.2 SEISMIC ISOLATORS

A. Do final positioning and adjusting of isolators after equipment is fully operational and while it is running.

3.3 VIBRATION ISOLATORS, BASES, AND PIPING CONNECTIONS

A. Provide vibration isolators, bases, and piping connections as indicated in the following tables.
   1. Superscript numbers in parentheses refer to notes at the end of the tables.

MOUNTED ON GRADE SUPPORTED SLAB					
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Pipe Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blowers/Fans			n/a
Air Compressors & Vacuum Pumps (8)					
Tank Mounted					
Horizontal	Up to 10 HP	3	0.75 IN	none	FPH
Horizontal	15 HP & Up	3	0.75 IN	C	FPH
Vertical	All	3	0.75 IN	C	FPH
Base Mounted	All	3	0.75 IN	C	FPH
Large Reciprocating	All	3	0.75 IN	C	FPH
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)					
Up to 22 IN	All	2	0.25 IN	B	n/a
24 IN and Up					
301 to 500 RPM	Up to 40 HP	3 & 5	1.50 IN	B	n/a
Above 500 RPM	Up to 40 HP	3 & 5	0.75 IN	B	n/a
301 to 500 RPM	50 HP & Up	3 & 5	1.50 IN	C	n/a
Above 500 RPM	50 HP & Up	3 & 5	1.00 IN	C	n/a
Piping	All	4	1.50 IN	none	none
Pumps					
Close Coupled	Up to 7.5 HP	2	0.25 IN	B	FPC

MOUNTED ON GRADE SUPPORTED SLAB					
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Pipe Connection Type (1,4)
	10 HP & Up	3	0.75 IN	B	FPC
Flex Coupled	Up to 40 HP	3	0.75 IN	B	FPC
	OVER 50 HP	3	0.75 IN	C	FPC
Large Inline	5 to 25 HP	3	0.75 IN	none	FPC
	30 HP & Up	3	0.75 IN	none	FPC
End Suction & Split Case	Up to 40 HP	3	0.75 IN	C	FPC
	50 to 125 HP	3	0.75 IN	C	FPC
	150 HP & Up	3	0.75 IN	C	FPC
Grouped On Base	All	1	0.30 IN	IP	FPC
Packaged Systems (8)	All	3	0.75 IN	C	FPC

MOUNTED ON STRUCTURAL FLOOR								
		21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Piping (9)								
First 3 supports from equipment connection	All	3	Note 11	none	3	Note 11	none	n/a
Remaining supports within 50 FT of equipment connection	All	3	0.75 IN	none	3	0.75 IN	none	n/a

SUSPENDED FROM STRUCTURE								
		21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Fans, Inline (2,3)	Up to 0.5 HP	3 or 3N	0.50 IN	none	3 or 3N	0.50 IN	none	n/a
	0.75 to 3 HP	3 or 3N	0.75 IN	none	3 or 3N	0.75 IN	none	n/a
	5 to 7.5 HP	3 or 3P & 5	1.50 IN	none	3 or 3P & 5	1.50 IN	none	n/a
	10 HP & Up	3 or 3P & 5	1.50 IN	none	3 or 3P & 5	2.50 IN	none	n/a
	10 HP & Up	3 or 3N & 5	1.50 IN	none	3 or 3N & 5	2.50 IN	none	n/a
Piping (9)								
First 3 supports from equipment connection	All	3P	Note 11	none	3P	Note 11	none	n/a
Remaining supports within 50 FT of equipment connection								
Suspended Individually	Up to 3 IN	3N	0.75 IN	none	3N	0.75 IN	none	n/a
	4 IN & Up	3P	0.75 IN	none	3P	0.75 IN	none	n/a
Suspended on Trapeze	All	3P	1.50 IN	none	3P	1.50 IN	none	n/a
	All	3N	2.50 IN	none	3N	2.50 IN	none	n/a
Piping in Mechanical Rooms and Sensitive Areas (10,12,15)								
	Up to 3 IN	3N	0.75 IN	none	3N	0.75 IN	none	n/a
	4 to 6 IN	3P	1.50 IN	none	3P	1.50 IN	none	n/a
	8 IN & Up	3P	1.50 IN	none	3P	1.50 IN	none	n/a

SUSPENDED FROM STRUCTURE								
Equipment	Horsepower & Other	21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe Connection Type (1,4)
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	
	8 IN & Up	3N	2.50 IN	none	3N	2.50 IN	none	n/a
Piping at Building Expansion and Seismic Joints								
Nonflammable Gases (non-medical)	All	n/a	n/a	none	n/a	n/a	none	FPH or Loop
Potable Water	All	n/a	n/a	none	n/a	n/a	none	FPC or Loop
Other Systems	All	n/a	n/a	none	n/a	n/a	none	Loop

MOUNTED ON ROOF								
Equipment	Horsepower & Other	21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe Connection Type (1,4)
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	
Air Handling Units With internal (blower) isolation	All	See Blower/Fans			See Blowers/Fans			n/a
Blowers/Fans								
	Up to 5 HP	3	0.75 IN	B	3	0.75 IN	B	n/a
	7.5 HP & Up	3	1.50 IN	B	3	1.50 IN	B	n/a
Condensers and Condensing Units								
Less than 25 Tons		4	1.50 IN	E	4	1.50 IN	E	Note 14
25 Tons & Up		4	2.00 IN	E	4	2.00 IN	E	Note 14

B. Notes to Tables:

1. Install piping connectors on equipment side of equipment isolation valves.
2. Size indicates diameter of wheel.
3. Provide Type 5 isolators on units operating at 2 IN or more static pressure.
   a. Mount one pair of isolators (on opposite sides) on each of fan's flexible connections.
   b. Adjust isolators to prevent flexible connections from extending to a tension condition.
   c. Attach isolators to duct at flanged joint through angle iron on back side of joint.
   d. See Section 23 31 13.
4. A swing joint with three flexible mechanical groove couplings may be substituted for an FPC.
5. Spring diameter: 2.5 IN.
6. Spring diameter: 4 IN.
7. Spring diameter: 6 IN.
8. On packaged systems, provide only external isolation.
9. Provide isolators on piping connected to vibrating equipment (i.e. equipment for which piping connections are specified).
10. Provide isolators for drainage and vent piping only if connected to vibrating equipment.
11. Same type as specified for equipment, except minimum deflection is 0.75 IN, and maximum deflection is 2.0 IN.
12. Mechanical rooms and sensitive areas:
    a. Mechanical rooms:
       1) Provide isolators for piping within mechanical rooms.
       2) Where isolators are indicated for piping connected to vibrating equipment, provide isolators which have the largest indicated minimum deflections.
13. Integral with base D.
14. Piping connection types:

a. Water: FPC.
b. Steam and refrigerant: FPH.

END OF SECTION

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SECTION 20 05 53
MECHANICAL IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Mechanical Identification Systems, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Piping system identification:
   1. ASME/ANSI-A13.1 Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Product Data:
   1. Pipe markers.
   2. Valve tags.
   3. HVAC duct markers.
   4. Equipment name plates.
   5. Access panel markers.
   6. Underground marking tape.

B. Contract Closeout Information:
   1. Valve Chart.
      a. Submit completed Spare Parts and Maintenance Material Transmittal form.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mechanical Identification Systems:
   1. Pipe, valve and equipment markers:
      a. Base:
         1) Seton Name Plate.
      b. Optional:
         1) Brady, WH.
         2) EMED.
         3) Kolbi Industries.
         4) 3M.
         5) Craftmark Identification Systems.
         6) Marking Services, Inc.
         7) Carlton Industries.
         8) Brimar.

B. Underground marking tape:
      a. Base:
         1) Reef Industries.
      b. Optional:
         1) Seton Name Plate.
         2) EMED.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 PIPE MARKERS

A. Conform to ASME/ANSI-A13.1.

B. Pressure sensitive vinyl self-adhesive material.

C. Mechanically fastened type: Snap on or strap on.
1. For dirty, greasy, oily pipe where pressure sensitive markers may not perform satisfactorily.

D. Provide with arrows indicating direction of flow.

E. Letter sizes: In accordance with table in Part 3.

2.3 VALVE TAGS

A. Brass or anodized aluminum type.

B. Brass:
1. Minimum 19 gauge, polished, 1-1/2 IN diameter with following lettering:
a. Service: 1/4 IN stamped black filled letters.
b. Valve numbers: 1/2 IN stamped black filled letters.

C. Aluminum:
1. 2 IN diameter, 0.032 IN thick, with following lettering:
a. Service: 1/4 IN engraved letters.
b. Valve numbers: 1/2 IN engraved letters.

D. Valve tag fasteners:
1. 4 ply 0.018 IN copper or monel wire meter seals, brass "S" hooks or No.16 brass jack chain.

2.4 HVAC DUCT MARKERS

A. HVAC Duct Markers:
1. 1-1/2 IN black stenciled letters denoting system number (e.g., AHU-1, RF-3, EF-5), type (supply, return, exhaust) and flow direction.

2.5 EQUIPMENT NAME PLATES

A. Equipment name plates:
1. 1/16 IN rigid plastic, Setonply, Emedolite or bakelite with four edges beveled; or engraved aluminum with black enamel background and natural aluminum border and letters.
a. Two 3/8 IN mounting holes.
b. Lettering size: Minimum 1/2 IN high.
c. Fasteners: Commercial quality, rust resisting nuts and bolts with backwashers, self-tapping screws or rivets.

B. Rotating equipment warning plates:
1. 1/16 IN rigid plastic, Setonply, Emedolite or bakelite with four edges beveled; or engraved aluminum with red enamel background and natural aluminum border and letters.
a. Two 3/8 IN mounting holes.
b. Lettering size: Minimum 1/2 IN high.
c. Fasteners: Commercial quality, rust resisting nuts and bolts with backwashers, self-tapping screws or rivets.
d. Lettering: “WARNING: ROTATING EQUIPMENT CAN BE REMOTELY/ AUTOMATICALLY STARTED AND STOPPED”.

2.6 ACCESS PANEL MARKERS

A. Metal Tack Style:
1. Use on acoustical tile ceilings.

2. Seton style BCM or ECM.

B. Engraved Plastic Style.
1. 3/4 IN square with center hole for small screw.
2. Seton style CM75.

2.7 UNDERGROUND MARKING TAPE

A. Underground Marking Tape:
1. 4 mil inert plastic film for underground use.
2. Resistant to alkalis, acids and other destructive agents found in soil.
3. Minimum tensile strength: 20 LBS per 3 IN width.
4. Minimum elongation: 500 percent.
5. Provide continuous printed message repeated every 16 to 36 IN warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
6. Color code:
   a. Blue: Water systems, domestic and fire.
7. Reef Industries, Standard Terra Tape.

B. Underground Detectable Marking Tape:
1. Lamination bond of 1 layer of aluminum foil between 2 layers of inert plastic film.
   a. Aluminum foil: Minimum 0.35 mils thick.
   b. Inert plastic film: Minimum 4.3 mils thick.
2. Resistant to alkalis, acids and other destructive agents found in soil.
3. Minimum tensile strength: 63 LBS per 3 IN width.
4. Minimum elongation: 500 percent.
5. Provide continuous printed message repeated every 16 to 36 IN warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
6. Tape to be inductively locatable and conductively traceable using a standard pipe and cable device for minimum of 8 years after burial.
7. Color code:
   a. Blue: Water systems, domestic and fire.
8. Reef Industries, Detectable Terra Tape.

2.8 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

A. Identify valves, with service designation and valve number designation on valve tags.
1. Tagging of valves at unit heaters, fan coil units, air terminal unit reheat coils and plumbing fixture stops are not required.
2. Install tags on valves using valve tag fasteners in manner for easy reading.

B. Furnish 4 charts including valve identification number, location (room number, department) and purpose.
1. Mount 1 chart in frame and secure on wall in location directed by Owner.
2. Include remaining 3 sets in Operation and Maintenance Manuals.

3.2 PIPE IDENTIFICATION

A. Fire-protection and Sprinkler Piping.
1. Painting required in finished areas.
2. Painting is required in exposed areas such as; mechanical/electrical rooms, accessible chases/shafts, rooms without ceilings, etc.

a. Color: Safety Red.
   1) See Section 09 91 23, Interior Painting.
b. Stencil on identification lettering and arrows indicating direction of flow.

B. Identify piping systems with indicated lettering:

Drawing Symbol	Pipe Identification Lettering
AV	Acid Vent
AW	Acid Waste
CD	Condensate Drain
CW	Domestic Cold Water
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
DW	Deionized Water
DWR	Deionized Water Return
ECWR	Equipment Cooling Water Return
ECWS	Equipment Cooling Water Supply
ERD	Emergency Roof Drain
F	Fire Protection
G	Natural Gas
HPR	High Pressure Steam Condensate Return (over 70 PSI)
HPS	High Pressure Steam (over 70 PSI)
HW(___)	Domestic Hot Water Supply (temperature)
HWC(___)	Domestic Hot Water Circulating (temperature)
HWR	Heating Hot Water Return
HWS	Heating Hot Water Supply
ICW	Industrial Cold Water
IHW(___)	Industrial Hot Water Supply (temperature)
IHC(___)	Industrial Hot Water Circulating (temperature)
LA	Laboratory Compressed Air
LPR	Low Pressure Steam Condensate Return (under 30 PSI)
LPS	Low Pressure Steam (under 30 PSI)
LV	Laboratory Vacuum
MPR	Medium Pressure Steam Condensate Return (30-70 PSI)
MPS	Medium Pressure Steam (30-70 PSI)
NPW	Non Potable Water
PCR	Pumped Condensate Return
RD	Roof Drain
S	Sprinklers
SS	Sanitary Sewer
V	Sanitary Sewer Vent

C. Locate identification lettering as follows:
1. Next to each valve and fitting, except on plumbing fixtures and equipment.
2. At each branch or riser take off.
3. At each passage through walls, floors and ceilings, both sides.
4. At each pipe passage to underground.
5. On horizontal pipe runs every 20 FT, at least once in each room, and each story traversed by piping system.
6. Identify piping contents, flow direction, supply and return.
7. So it is readable from access panels and not obscured by other work.
8. At least once in or above every room.

D. Size lettering, marker color fields, and arrows as follows:

IN	IN	IN
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

E. Pipe Markers:
1. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 DUCTWORK IDENTIFICATION

A. Locate duct markers as follows:
1. At each branch or riser take-off.
2. Next to equipment.

B. Stencil ductwork or exterior surface of insulation.

3.4 EQUIPMENT IDENTIFICATION

A. Attach equipment nameplates in conspicuous location, directly on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
1. Secure nameplates with self-tapping screws, or nuts and bolts.

B. Attach rotating equipment warning plates in conspicuous location, directly on each item of equipment with exposed motor such as; pumps, fans, compressors, vacuum pumps, etc.
1. Secure nameplates with self-tapping screws, or nuts and bolts.

C. For unsuitable surfaces, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

D. Identify devices located above ceilings with additional identification.
1. Use access panel markers (metal tack style) for acoustical tile ceilings, or engraved plastic style, 3/4 IN square, for mounting on panel door; or equipment nameplates.
2. Coordinate with Owner on identification method and color codes.
3. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc., and other mechanical items that may need servicing or adjustment. Glue marking tacks in place to prevent their falling out.
4. Where fire protection devices are located inside ductwork, provide an additional tag on the duct access door identifying device inside.
   a. Identification letter size: 1-1/2 IN high minimum.
5. Color code access panel markers as follows:
   a. Red: Fire dampers, smoke detectors, sprinkler shutoff valves and duct type smoke detectors.
      1) Notation:
         D - Damper
         V - Valve
         S - Smoke Detector
         H - Heat Detector
   b. Yellow: Steam, radiation, reheat and chilled water valves:
      1) Notation:
         V - Valve

c. Gold: Automatic and balancing devices:
   1) Notation:
      V - Valve
      D - Damper

3.5 INSTALLATION OF UNDERGROUND MARKING TAPE

A. See Section 20 10 10.

END OF SECTION

SECTION 20 07 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Pipe, Duct and Equipment Insulation, as indicated, in accordance with provisions of Contract Documents.

B. Insulation Applications:
1. Pipe insulation.
2. Duct insulation.
3. Equipment insulation.
4. Insulation jacketing and prefabricated fitting covers.
5. Insulation fasteners: Adhesives, mastics, and caulking.
6. Air Ventilation Duct Wrap Fire Protection Systems.
7. Special Considerations at hangers and bracing: See Section 20 05 29 Penetrations and Supports.

C. Definitions:
1. Concealed: Outside surfaces are isolated from room ambient air conditions by physical barrier.
   a. Concealed items are typically accessed through suspended ceilings, through access doors, or by cutting and patching.
   b. Listed below are examples of spaces that typically contain concealed items:
      1) Walls.
      2) Partitions.
      3) Chases.
      4) Shafts.
      5) Ceiling spaces.
2. Exposed: Outside surfaces are not isolated from room ambient air conditions by physical barrier.
   a. Exposed items are typically accessed directly from within a room or space.
   b. Listed below are examples of rooms/spaces that typically contain exposed items:
      1) Mechanical and electrical rooms.
      2) Rooms without ceilings.
      3) Below ceilings of rooms.
3. Exposed to weather: Outside surfaces are not isolated by physical barrier(s) from weather or outside ambient air conditions.
4. Runouts: Piping not more than 12 FT in length.
5. Thermal conductivity (k): Btu/(h-ft-°F).
6. Serviceable: Strainers, steam traps, cleanouts.
7. Non-Serviceable: Fittings, valves.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with the following fire and smoke hazard ratings:
1. Test products by procedure ASTM E84, NFPA-255 and ANSI/UL-723.
2. Rating requirements:
   a. Maximum Flame Spread: 25.
   b. Maximum Smoke Developed: 50.
3. Properly identify products for flame and smoke ratings.
   a. Shipping cartons may be labeled instead of product.

B. Comply with requirements of the following:
   1. ASTM C547 Standard Specification for Mineral Fiber Preformed Pipe Insulation.
   2. ASTM C534, Standard Specification for Preformed Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      a. Products are allowed to deviate from this standard with regard to insulation density.
   3. ASTM C552-00 Standard Specification for Cellular Glass Thermal Insulation.
   4. ASTM C585, Recommended Practice for Inner and Outer Diameters of Rigid Pipe 'Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
   5. ASTM C1136, Standard Specification for Flexible Low Permeance Vapor Retarders for Thermal Insulation.
   6. ASTM C795, Thermal Insulation for Use Over Austenitic Stainless Steel.
   7. ASTM E 84, Surface Burning Characteristics: Underwriters Laboratories Applied Fireproofing Listing Nos. 11660-2, 11660-4.
   8. ASTM E 814, Through-Penetration, 2-Hour Firestop Test.
   9. ASTM E 119, Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
   10. ASTM C 518, Aging Test, Steady State Heat Flux Measurements and Thermal Transmission Properties.
   11. ASTM E 162, Surface Flammability of Materials.
   12. ASTM E 136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
   13. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
   14. National Commercial and Industrial Insulation Standards.
      a. Published by Midwest Insulation Contractors Association (MICA).
      b. Endorsed by National Insulation Association (NIA).
      c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

A. Product Data:
   1. Pipe insulation.
   2. Precut insulation inserts.
   3. Ductwork insulation.
   4. Insulation for hot equipment.
   5. Insulation for cold equipment.
   6. Jacketing and prefabricated fitting covers.
   7. Insulation fasteners.
   8. Schedule of services and insulation thicknesses.
   9. Air Ventilation Duct Wrap Fire Protection Systems:
      a. Submit reports substantiating code compliance along with manufacturer's installation instructions.

PART 2 - GENERAL

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe, Duct and Equipment Insulation:
   1. Insulation materials:
      a. Base: As indicated.
      b. Optional:
         1) Owens-Corning Fiberglass.
         2) Armacell.
         3) Nomaco K-Flex.
         4) CertainTeed Insulations.
         5) Knauf Insulation.
         6) Johns Manville.
         7) Pittsburgh Corning.

2. Air Ventilation Duct Wrap Fire Protection Systems:
   a. Base:
      1) Thermal Ceramics.
   b. Optional:
      1) Unifrax Corporation.
      2) 3M.
3. Jacketing:
   a. Base: As indicated.
   b. Optional:
      1) Ceel-Co.
      2) Childers Products.
      3) Johns Manville.
      4) Proto PVC Corporation.
      5) RPR Metals.
      6) Pabco Metals Corporation.
4. Prefabricated fitting covers:
   a. Base: As indicated.
   b. Optional:
      1) Ceel-Co.
      2) CertainTeed Insulations.
      3) Childers Products.
      4) Proto PVC Corporation.
      5) Johns Manville.
      6) RPR Metals.
      7) Pabco Metals Corporation.
5. Adhesives, mastics, caulkings, and finishes:
   a. Base: As indicated.
   b. Optional:
      1) Foster Products, Division of HB Fuller.
      2) Armacell.
      3) Childers Products.
      4) Dow Corning.
      5) Johns Manville.
      6) Knauf Insulation.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. General:
   1. Do not use material that exceeds specified flame and smoke ratings.
   2. Use permanent treatments to jacketings and facings to impart specified fire ratings.
   3. Use of water soluble treatments is prohibited.

2.3 PIPE INSULATION - NON-FLEXIBLE FIBERGLASS

A. Preformed commercial-grade fiberglass.

B. Temperature range: 0 to 850 DEGF.

C. Thermal conductivity at mean temperature:
   1. k ≤ 0.23, 75 DEGF.
   2. k ≤ 0.29, 200 DEGF.
   3. k ≤ 0.54, 500 DEGF.

D. Facing: All service jacket.

E. Integral vapor retarder: Provide where indicated in Part 3.

F. Seams, longitudinal: 2 IN self-sealing facing tabs.
   1. Provide adhesive on both contacting surfaces.
   2. Designed to perform without stapling.

2.4 PIPE INSULATION - NON-FLEXIBLE CELLULAR GLASS

A. Material: Commercial-grade closed-cell inorganic glass insulation.

B. Temperature range: –450 to 900 DEGF.

C. Minimum density: 7.5 PCF.

D. Thermal conductivity at mean temperature:
   1. k ≤ 0.28, 50 DEGF.
   2. k ≤ 0.29, 75 DEGF.

E. Fittings: Factory fabricated shapes designed for specific fittings.

F. Base product: Pittsburgh Corning Foamglas.

2.5 PIPE INSULATION - FLEXIBLE

A. Commercial-grade closed-cell elastomeric or unicellular polyolefin thermal insulation.

B. Temperature range: 40 to 200 DEGF.

C. Thermal conductivity at mean temperature:
   1. k ≤ 0.27, 75 DEGF.
   2. k ≤ 0.276, 90 DEGF.

D. Seams, longitudinal: Factory-cut and self-sealing.
   1. Base product: AP Armaflex SS.

2.6 DUCTWORK INSULATION - NON-FLEXIBLE

A. Boards for rectangular ductwork:
   1. Commercial-grade fiberglass thermal insulation formed with a thermosetting resin into semi-rigid or rigid boards.
   2. Temperature range: 0 to 450 DEGF.
   3. Minimum density:
      a. Semi-rigid: 3.0 PCF.
      b. Rigid: 6.0 PCF.
   4. Thermal conductivity at mean temperature:
      a. Semi-rigid:
         1) k ≤ 0.22, 75 DEGF.
         2) k ≤ 0.27, 150 DEGF.
         3) k ≤ 0.38, 300 DEGF.
      b. Rigid:
         1) k ≤ 0.23, 75 DEGF.
         2) k ≤ 0.27, 150 DEGF.
         3) k ≤ 0.37, 300 DEGF.
   5. Facing: All-Service-Jacket (ASJ).
      a. Temperature range: -20 to 150 DEGF.
   6. Base Products:
      a. Semi-Rigid: Owens-Corning Fiberglas Type 703.
      b. Rigid: Owens-Corning Fiberglas Type 705.

B. Wrap for round and flat-oval ductwork:
   1. Commercial-grade fiberglass thermal insulation formed with a binder into a semi-rigid blanket.
   2. Temperature range: 0 to 850 DEGF.

3. Minimum density:
   a. Semi-rigid: 2.5 PCF.
4. Thermal conductivity at mean temperature:
   a. Semi-rigid:
      1) k ≤ 0.24, 75 DEGF.
      2) k ≤ 0.28, 150 DEGF.
      3) k ≤ 0.39, 300 DEGF.
5. Facing: All-Purpose-Jacket (AP).
6. Base Products:
   a. Semi-Rigid: Johns Manville Micro-Flex.

2.7 DUCTWORK INSULATION - FLEXIBLE

A. Interior Use:
   1. Commercial-grade fiberglass thermal insulation, formaldehyde free.
   2. Temperature range: 40 to 250 DEGF.
   3. Thermal conductivity at mean temperature: k ≤ 0.27, 75 DEGF.
   4. Installed R-value: 8.0 HR-ft2-°F/BTU based on 2-1/2 IN nominal thickness.
   5. Density: 0.75 PCF.
   6. Facing: Foil-Reinforced-Kraft (FRK) vapor-retarding.
   7. Seams: 2 IN facing tab.
   8. Base product: Owens-Corning Fiberglass commercial-grade all-service duct wrap.

2.8 INSULATION FOR HOT EQUIPMENT

A. Same as Pipe Insulation - Nonflexible.

2.9 INSULATION FOR COLD EQUIPMENT

A. Material: Commercial-grade elastomeric thermal insulation.

B. Designed for application with complete adhesive coverage on systems operating at temperatures between -40 and 180 DEGF.

C. Thermal conductivity at mean temperature:
   1. k ≤ 0.27, 75 DEGF.
   2. k ≤ 0.276, 90 DEGF.

D. Base product: AP Armaflex sheet insulation.

2.10 VENTILATION DUCT WRAP FIRE PROTECTION SYSTEMS

A. High temperature inorganic foil encapsulated flexible fireproofing wrap.
   1. Performance:
      a. Fire rating: 1 or 2 hour, as required to match the penetration rating.
   2. Clearance to combustibles rating: Zero clearance.
   3. Thickness: 1-1/2 IN.
   4. Density: 6 PCF.
   5. Encapsulated maximum flame spread rating: 25.
   6. Encapsulated maximum smoke developed rating: 50.

B. Ventilation Duct Standards compliance:
   1. ISO 6944-1985.
   2. ASTM E814 Firestop Test F-Rating: 2 hours.
   3. ASTM E814 Firestop Test T-Rating: 2 hours.
   4. ASTM E119 Full Scale Engulfment test fire rating: 2 hour.

C. Tapes:
   1. As directed by and approved by manufacturer installation requirements.

D. Banding Material:
   1. Stainless steel: Minimum 1/2 IN wide x 0.015 IN thick.

E. Insulation Pins and Washers:
   1. As directed and approved by manufacturer installation requirements.

F. Through Penetration Firestop Materials:
   1. As directed by and approved by manufacturer installation requirements.

2.11 JACKETING AND PREFABRICATED FITTING COVERS

A. General:
   1. Fitting Covers:
      a. Designed to fit over precut insulation inserts.
      b. Designed specifically for fitting being covered.
      c. 2-gore covers are not acceptable.

B. Jacketing and Fitting Covers:
   1. High impact PVC.
   2. Minimum 0.028 IN thick.
   3. Resistant to bacterial growth, mildew, and corrosion.
   4. Minimum 1 IN overlap at joints.
   5. Base manufacturer: Johns Manville Zeston 2000 series.

C. Metal Jacketing and Fitting Covers:
   1. Material: As indicated in Part 3.
   2. On cold systems and equipment, provide factory moisture barrier.
   3. Attaching method:
      a. 0.020 x 3/8 IN bands on 9 IN centers unless indicated otherwise in Part 3.
      b. Band material: Same as jacketing and covers.
   4. Minimum 2 IN overlap at joints.
   5. Tubular jacketing: Locking longitudinal seams.
   6. Base manufacturer: Childers.

2.12 INSULATION FASTENERS

A. Insulation Adhesive:
   1. Flexible pipe insulation: Manufacturers standard adhesive as approved for application.
   2. Foster 30-36.
   3. Foster Spark-Fas 85-70.
   4. Insulation adhesive shall have a VOC content no greater than 70 g/L.

B. Insulation Mastic:
   1. Childers CP-30.
   2. Foster 35-00-GPM.
   3. Mastic coatings shall have a VOC content no greater than 100 g/L.

C. Insulation Caulking:
   1. Dow No.11.
   2. Caulking shall have a VOC content no greater than 250 g/L.

PART 3 - GENERAL

3.1 APPLICATION

A. General:
   1. Apply products per manufacturer's recommendations and as specified.
      a. Include allowance for thermal expansion and contraction.
   2. MICA plate numbers are listed under some insulation applications to clarify scope and acceptable methods of insulation application for particular listing.

3. Do not insulate piping until satisfactory completion of required pressure tests.
4. Apply insulation to clean, dry surfaces and within manufacturers recommended temperature range.
5. Butt edges of insulation firmly together, and seal joints with compatible jackets, facings and adhesives as specified.
6. Apply insulation with a continuous, unbroken vapor retarder including, but not limited to, insulation of following.
   a. Vapor seals on hangers, supports, and anchors secured directly to cold surfaces.
7. Continue insulation through sleeves and wall and ceiling openings.
8. Insulate fittings, unions, valve bodies, flanges and other pipeline accessories.
9. Insulation at piping supports: Coordinate with Section 20 05 29.
10. Insulation installed in multiple layers: Stagger joints between layers.

3.2 PIPE INSULATION - NONFLEXIBLE FIBERGLASS

A. General:
   1. Provide either type of lap seal at joints:
      a. Self-sealing facing tabs.
      b. 3 IN wide pressure-sensitive joint-sealing tape matching facing.
         1) Manufacturer: Same as insulation.
      c. Insulation application standard: MICA plate number 1-100.
      d. Insulation application for heat traced piping standard: MICA plate number 1-900.
   2. Fittings:
      a. On non-serviceable items, use either of the following methods:
         1) Built-up systems:
            a) Elbows: MICA plate numbers 2-100 through 2-800 as applicable.
            b) Valves and fittings: MICA plate number 2-530 or 2-536 as applicable.
            c) Flanges: MICA plate number 2-535.
            d) Tees: MICA plate number 2-120.
         2) Prefabricated fitting cover encapsulated:
            a) Elbows: MICA plate number 2-500.
            b) Valves and fittings: MICA plate number 2-130.
            c) Flange or grooved coupling: MICA plate number 2-535.
      b. Serviceable items: Provide prefabricated fitting covers attached with bands.
         1) Exception: On systems exposed to weather, attach with method described as best by manufacturer.
      c. Exposed fittings, flanges, valves, and pipe terminations: Provide prefabricated fitting covers.
      d. Built-up system:
         1) 2 IN and smaller: Finish with mineral fiber cement to thickness of adjoining pipe insulation.
         2) 2-1/2 IN and larger: Insulate with insulation insert, mitered pipe insulation segments or preformed fiberglass fittings.
            a) Secure with vinyl faced insulation strapping tape or 20 AWG galvanized annealed wire finished with one coat of mineral fiber cement.
         3) Finish with Glass Fab embedded in two coats of Foster 30-36 adhesive.

B. Provide non-flexible insulation on following piping systems in wall thickness indicated:
   1. Hydronic systems:
      a. Heating water piping, with or without glycol to 200 DEGF:
         1) 1-1/4 IN and smaller: 1-1/2 IN.
         2) 1-1/2 IN and greater: 2 IN.
   2. Plumbing systems:
      a. Domestic and Industrial hot/recirculating water piping, 100 to 140 DEGF:
         1) 1-1/4 IN and smaller: 1 IN.
         2) 1-1/2 IN and greater: 1-1/2 IN.

3. Low pressure steam and steam condensate piping, 15 PSI or less, pumped condensate return, condensate vent, blowdown, boiler feed, and exhaust steam piping:
   a. 3 IN and smaller: 2-1/2 IN.
   b. 4 IN and larger: 3 IN.
4. Medium pressure steam and steam condensate piping, 16 PSI to 100 PSI:
   a. 3/4 IN and smaller: 3 IN.
   b. 1 IN and larger: 4-1/2 IN.
5. High pressure steam and steam condensate piping greater than 100 PSI:
   a. 3/4 IN and smaller: 4-1/2 IN.
   b. 1 IN and larger: 5 IN.

C. Piping Within Air Handling Units:
1. Flame-resistant, aluminum-faced, vapor retarder jacket over non-flexible insulation on steam, condensate-return, and heating-water piping inside air handling units.
2. Extend vapor retarder jacket outside of unit enclosure.
3. Cover joints with 3 IN wide pressure sensitive tape matching jacket.

3.3 PIPE INSULATION - NONFLEXIBLE CELLULAR GLASS

A. General:
1. Install using system components and methods recommended by manufacturer for service temperature of piping system.

B. Provide non-flexible insulation on following piping systems in wall thickness indicated:
1. Hydronic systems:
   a. Chilled water piping, with or without glycol 40 to 55 DEGF:
      1) 1-1/2 IN and smaller: 1 IN.
      2) 2 IN and greater: 1-1/2 IN.
   b. As an insulation pipe saddle support insert:
      1) All systems, size to match existing pipe insulation.

3.4 PIPE INSULATION - FLEXIBLE

A. General:
1. Install insulation sleeve over piping.
2. Do not make longitudinal field cuts.
3. Seal joints with manufacturer approved adhesive.
4. Do not use flexible pipe insulation on systems with heat tracing cable or temperature maintenance cable.

B. Fittings:
1. Insulate fittings and valve bodies with segments cut from pipe insulation.

C. Provide flexible insulation on following piping systems in wall thickness indicated:
1. Hydronic systems:
   a. Cooling coil condensate:
      1) All sizes: 1 IN.
   b. Equipment cooling water piping, with our without glycol, 40 to 55 °F:
      1) 1 1/2 IN and smaller: 1 IN.
      2) 2 IN and above: 1 1/2 IN.
2. Refrigerant systems:
   a. Refrigerant/brine piping:
      1) 1-1/4 IN and smaller: 1 IN.
      2) 1-1/2 IN and larger: 1-1/2 IN.
3. Plumbing systems:
   a. Domestic and Industrial cold water piping:
      1) 1-1/2 IN and smaller: 1/2 IN.
      2) 2 IN and larger: 1 IN.

b. Waste piping from water coolers and drinking fountains to first point of mixing with waste from a different type of fixture:
   1) All sizes: 1/2 IN.
c. Horizontal rain leaders, including overflow systems and 24 IN up and down from horizontal and up to underside of roof deck:
   1) All sizes: 1 IN.
   2) Rain leaders are cold systems.
d. Horizontal condensate drain leaders (serving condensate drain discharge from cooling coil condensate drains) and floor drain:
   1) All sizes: 1 IN.
   2) Condensate drain leaders are cold systems.

3.5 DUCTWORK INSULATION - NONFLEXIBLE

A. General:
1. Secure insulation to ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.
   a. Secure insulation on mechanical fasteners with speed clips.
   b. Space mechanical fasteners to hold insulation securely in place.
      1) Maximum spacing: 12 IN centers.
2. Where access is not possible for pin attachment, use adhesive or caulk.
   a. Cover entire surface with brush applied adhesive.
   b. Apply caulk in continuous bead on 6 IN centers.
3. Seal joints and speed clips with 3 IN wide pressure-sensitive joint-sealing tape matching facing.
   a. Staple corners of tape with outward clinching staples.
4. Cold systems only: Coat staples with mastic.
5. Reinforce edges with metal corner angles.
6. Apply insulation to ductwork from unit housing to ends of duct runs including diffuser necks and register ducts.
7. Do not apply insulation over coil and damper access panels.
8. Do not apply insulation over internally lined ductwork: Coordinate with Section 23 31 13.

B. Provide non-flexible insulation on following ductwork in thickness indicated:
1. Supply-air ductwork, exposed:
   a. All sizes: 1-1/2 IN.
2. Return-air ductwork in non-air conditioned areas, exposed:
   a. All sizes: 1-1/2 IN.

3.6 DUCTWORK INSULATION - FLEXIBLE

A. General:
1. On ductwork 24 IN wide and less, secure insulation to bottom of ductwork with 4 IN wide bands of brush-applied adhesive on 12 IN centers.
2. On ductwork over 24 IN wide, secure insulation to bottom of ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.
   a. Secure insulation on mechanical fasteners with speed clips.
   b. Space mechanical fasteners to hold insulation securely in place.
      1) Maximum spacing: 12 IN centers.
   c. Seal speed clips with 3 IN wide pressure-sensitive joint-sealing tape matching jacket.
      1) Staple corners of tape with outward clinching staples.
      2) Cold systems only: Seal staples with mastic.
3. Provide either type of lap seal at joints:
   a. Seal facing tab over adjoining facing with lap adhesive.
      1) Secure lap with outward clinching staples on 6 IN centers.
   b. Use 3 IN wide pressure-sensitive joint-sealing tape that matches facing.
      1) Secure both sides of tape with outward clinching staples on 6 IN centers.

c. Cold systems only: Seal staples with mastic.
4. Apply insulation to ductwork from unit housing to ends of duct runs, including diffuser necks and register ducts.
5. Do not apply insulation over coil and damper access panels.
6. Do not apply over internally lined ductwork: Coordinate with Section 23 31 13.

B. Provide flexible insulation on following ductwork in thickness indicated:
1. Supply-air ductwork, including downstream of terminal units, sound attenuators, reheat coil casings and tube ends, except where specified to be internally lined or specified to be covered by nonflexible insulation:
a. All sizes: 2-1/2 IN; minimum installed R-value of 8.0.
2. Return-air ductwork in non-air conditioned areas (including utility shafts), except where specified to be internally lined or specified to be covered by nonflexible insulation:
a. All sizes: 2-1/2 IN; minimum installed R-value of 8.0.
b. Ceiling spaces directly above conditioned spaces are considered conditioned.

3.7 INSULATION - HOT EQUIPMENT

A. General:
1. Secure insulation to bottom of flat surfaces wider than 24 IN by impaling over adhesive-pin mechanical fasteners.
a. Secure insulation on mechanical fasteners with speed clips.
b. Space mechanical fasteners to hold insulation securely in place.
1) Maximum spacing: 12 IN centers.
2. Seal joints and speed clips with 3 IN wide pressure-sensitive joint-sealing tape that matches facing.
a. Secure both sides of tape with outward clinching staples on 3 IN centers, 1/4 IN from edge.
3. Insulate flanges and fittings as indicated under Pipe Insulation, Nonflexible.
4. Reinforce ends and irregular surfaces with Glass Fab embedded in two coats of Foster 30-36 adhesive.

B. Provide hot-equipment insulation on following equipment in thickness indicated:
1. Air separators: 2 IN.
a. Insulation assembly standard: MICA plate number 4-100 or 4-120.
2. Condensate receivers above grade: 2 IN.
3. Domestic and Industrial hot water recirculating pumps: 2 IN.
4. Domestic and Industrial hot water expansion tanks: 2 IN.
5. Flash tanks: 2 IN.
a. Insulation assembly standard: MICA plate number 4-120.
6. Heating water expansion tanks: 2 IN.
a. Insulation assembly standard: MICA plate number 4-100 or 4-120.
7. Steam-to-water heat exchangers: 2 IN.
a. Insulation assembly standard: MICA plate number 4-130.
8. Water-to-water heat exchangers: 2 IN.
a. Insulation assembly standard: MICA plate number 4-130.

3.8 INSULATION - COLD EQUIPMENT

A. Apply insulation with adhesive and coatings approved by manufacturer.
1. Completely cover joining surfaces (equipment surfaces, and back and butting edges of insulation).
2. Apply with 1/8 IN overlay pressure on butt joints.
3. Apply two coats of white latex enamel to outside layer.

B. Provide cold-equipment insulation on following equipment in number of layers and total thickness indicated:
   1. Chilled water and Equipment cooling water pump casing: 1 layer, 3/4 IN.
      a. Insulation assembly standard: MICA plate number 50.
   2. Domestic cold water meter: 1 layer, 3/4 IN.
      a. Insulation assembly standard: MICA plate number 8-400.
   3. Roof drain bodies: 1 layer, 3/4 IN.

3.9 AIR VENTILATION DUCT WRAP FIRE PROTECTION SYSTEMS

A. General installation methods:
   1. Acceptable application methods:
      a. Telescoping overlap.
      b. Butt joint with collar wrap.
   2. Utilize stainless steel banding to attach the material to the duct; space banding per manufacturers guidelines.

B. Provide air ventilation duct wrap on following ductwork in thickness required to meet wall assembly rating:
   1. Where noted on plans.
   2. Laboratory exhaust duct penetrations through fire rated walls.

3.10 JACKETING AND PREFABRICATED FITTING COVERS

A. General:
   1. Stagger jacketing and insulation joints.

B. Interior exposed systems:
   1. Material for piping higher than 10 FT above finished floor or platform: PVC.
   2. Material for piping up to 10 FT above finished floor or platform: 0.016 IN corrugated aluminum.
   3. Material for fittings, and equipment if not defined otherwise: 0.016 IN corrugated aluminum.
   4. Attach as recommended by manufacturer.

C. Systems exposed to weather:
   1. Material:
      a. 0.016 IN corrugated aluminum.
   2. Attach as recommended by manufacturer.
   3. Joints:
      a. Orient joint laps to prevent entry of water.
      b. Seal joints weather tight.

D. Hot Equipment:
   1. Material:
      a. 0.016 IN corrugated aluminum.
   2. Attach as recommended by manufacturer.

END OF SECTION

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SECTION 20 08 00
TESTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Testing and Balancing, as indicated, in accordance with provisions of Contract Documents.

B. Test, balance and adjust following mechanical systems:
   1. Air distribution systems.
   2. Air handling units and air moving equipment.
   3. Heating hot water systems including pumps.
   4. Chilled water systems including pumps.
   5. Heating and cooling coils.
   6. Existing air distribution systems affected by new installation.
   7. Existing hydronic systems affected by new installation.
   8. Temperature Controls:
      a. Assist Temperature Controls installer with calibration of air and waterside control components such as airflow stations, flow meters, etc. as outlined in Section 25 50 00.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Agency qualifications: Independent test and balance agency, member of Associated Air Balance Council (AABC), or National Environmental Balancing Bureau (NEBB).
   1. Work supervised by a certified Testing and Balancing Engineer.
   2. Indicate at least 5 successfully completed projects of similar size and scope.

B. Testing and balancing standards: AABC or NEBB standards and procedures.

1.3 RESPONSIBILITIES OF TESTING AND BALANCING (TAB) AGENCY

A. Review contract document ductwork drawings before bid and advise Air Distribution contractor as to the number and size of additional branch main volume dampers required to facilitate balancing.

B. In accordance with Section 23 31 13, review contractor ductwork installation drawings before fabrication and advise where additional volume dampers are required to facilitate balancing.

C. Schedule work with trades involved.

D. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

E. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

F. Prepare and submit test reports.

1.4 RESPONSIBILITIES OF MECHANICAL INSTALLER

A. Coordinate and schedule with testing agency.

B. Startup system and keep in correct operation during balancing operations.

C. Provide necessary adjustments and corrections to systems as directed by Testing and Balancing Agency.

D. Maintain accessibility to test locations and devices requiring adjustment.

E. Provide additional sets of pulleys and belts as required by Testing and Balancing Agency.

F. Provide a complete set of approved mechanical-equipment shop drawings to Testing and Balancing Agency.

G. Provide a complete set of "As-built" drawings to Testing and Balancing Agency.

1.5 JOB CONDITIONS

A. Balance at time directed by Architect.
   1. If balancing is not done during peak cooling season demonstrate satisfactory balancing during next peak cooling season.

B. Keep dust, dirt and debris to an absolute minimum and reinstall removed ceiling tiles to original positions at end of each work day.

1.6 CORRECTIVE WORK

A. Provide extended warranty of ninety (90) days, after completion of test and balance work, during which time Architect may, at Architect's discretion, request recheck or resetting of equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.7 SUBMITTALS

A. Project Information:
   1. Within sixty (60) days of award of contract submit a complete Submission Report including:
      a. A company resume listing its personnel and project experience in air and hydronic balancing.
      b. An inventory and calibration data of instruments and devices in possession of balancing agency whether or not they will be used on this project.
      c. A working agenda that includes procedures for testing and balancing each air and water flow system.
      d. Test and Balance Report Forms and Field Data Sheets that will appear in final report, with design data already filled in.
      e. A written, system-by-system description of measurements, test locations and procedures that will be employed during test and balance.

B. Contract Closeout Information:
   1. Final test and balance report:
      a. Use forms similar to AABC or NEBB latest editions.
      b. Report(s) signed by TAB Engineer.

PART 2 - PRODUCTS

2.1 JOB SITE INSPECTIONS

A. During construction inspect installation of piping, sheet metal work, temperature controls, flow meters, pressure taps, strainers and other components of HVAC system as specified in contract documents.

B. Note any deficiencies and submit them, in writing, to Architect.
   1. Include these inspection reports in final TAB report.

2.2 FINAL TEST AND BALANCE REPORT

A. Using field data, test forms and procedures outlined in Submission Report, perform and record measurements, and complete final TAB report including:
   1. Preface:
      a. General discussion of system including any abnormalities and problems encountered.
   2. Instrumentation list:
      a. List of instruments including type, model, manufacturer, serial number and calibration date.
   3. System identification:
      a. On each Test and Balance Report Form, number and/ or letter air terminal units, zones, supply, return and exhaust openings and traverse points to correspond to numbers and letters on Field Data Sheets.
   4. Air handling equipment:
      a. Manufacturer, model number, and serial number.
      b. Design and manufacturer related data.
      c. Total actual air flow rate by traverse if practical; if not practical, sum of outlets may be used, or a combination of each of these procedures.
         1) For specific systems, such as ones with diversity, see AABC National Standards.
      d. Suction and discharge static pressure of each fan, as applicable.
      e. Outside air and return air total air flow rate.
      f. Actual operating current, voltage, and brake horse power of each fan motor.
      g. Final RPM of each fan.
      h. Fan and motor sheave manufacturer, model, size, number of grooves and center distance.
      i. Belt size and quantity.
      j. Static pressure controls final operation set points.
   5. Pumps:
      a. Manufacturer, size, and serial number.
      b. Design and manufacturer's related data.
      c. Pump operating suction and discharge pressures, and final total dynamic head.
      d. No-flow (pump discharge valve closed) suction and discharge pressures, and corresponding total dynamic head. (This procedure is to determine actual impeller size.)
      e. Rated and actual operating current, voltage and brake power of each pump motor.
      f. Submit pump curve indicating design, operating, and no-flow points of operation.
   6. Heat exchangers:
      a. Manufacturer and model number.
      b. Design and manufacturer's related data.
      c. Service and location.
      d. Actual pressure drop and related water flow rate or steam pressure, primary side.
      e. Actual pressure drop and related water flow rate or steam pressure, secondary side.
      f. Primary side entering and leaving temperatures. (Not applicable for steam-to-water heat exchangers.)
      g. Secondary side entering and leaving temperatures.
      h. Temperature control setting.
   7. Heating and cooling coils:
      a. Manufacturer.
      b. Design and manufacturer's related data.
      c. Rated and actual water pressure drops through each coil and related water flow rate.
      d. Rated and actual static air pressure drops across each coil.
      e. Entering and leaving water temperatures.
      f. Air wet bulb and dry bulb temperatures entering and leaving each cooling coil.
      g. Air dry bulb temperatures entering and leaving each heating coil.
      h. Water flow rate from flow stations or steam pressure.

8. Air terminal units, diffusers, registers and grilles:
   a. Adjust air terminal units to deliver design maximum and minimum air-flow conditions.
   b. Flow rate at each air outlet (diffuser).
   c. Flow rate at each return and exhaust air inlet (register or grille).
9. Room Pressure relationships.
   a. Maintain pressure relationships in rooms that are either positive (supply greater than return/ exhaust) or negative (supply less than return/exhaust).
   b. In the final test and balance report, indicate that these pressure relationships were maintained.

B. Units of measure:
1. Flow rates:
   a. Air: .
   b. Water: ____ GPM.
2. Temperatures: ____ DEGF.
3. Pressures:
   a. Air: ____ IN WC.
   b. Steam: ____PSIG.
   c. Water: ____ PSIG.
4. Pump heads: ____ FT.
5. Power: ____ HP.

PART 3 - EXECUTION

3.1 GENERAL

A. Final reports are required to be completed and submitted far enough in advance of local agencies final inspections for occupancy to provide adequate time for Engineer to review, Contractor to correct any deficiencies and reports to be revised for agencies final inspections.

B. Coordinate and schedule testing and balancing with Contractor and Mechanical Contractor.
1. Report deficiencies in systems to Mechanical Contractor for resolution.

C. Accurately calibrate and maintain test instruments in good working order.
1. If requested, conduct tests of instruments in presence of Engineer.

D. If requested, conduct balancing tests in presence of Engineer.

E. Do not begin balancing until system(s) have been substantially completed and are in good working order to permit preliminary measurements of total air or water volumes and system pressures.

F. Proceed with final balancing and adjustments when systems are 95 to 100 % complete.

G. Record inspections, tests and adjustments.

3.2 AIR BALANCING METHODS

A. Balance each air system that is served by air filters, using artificial static loading of system, to demonstrate, test and obtain system design pressure drop data.
1. Provide dirty filter pressure drop conditions on system.
2. Do not use high efficiency filters (75 % and above) in testing and balancing.
3. Static pressure losses may be simulated by using wood or sheet steel blanking plates in high efficiency filter racks and housings.
4. Do not install blanking plates within 2 FT of low efficiency filter unit or rack.

3.3 AIR BALANCE TESTING PROCEDURE

A. Perform tests and balance system in accordance with approved Submission Report.

B. Take readings of airflow stations if installed or make pitot tube traverse of main supply, return and exhaust air ducts.
   1. Obtain flow rates at fans at both maximum and minimum outside air operation.

C. Test and adjust each diffuser, grille, and register served by an air terminal unit to within 10 % of design requirements.

D. In cooperation with HVAC Controls installer, set automatically operated dampers to operate as indicated.
   1. Check controls for proper calibration and list controls requiring adjustment.

3.4 WATER BALANCE TESTING PROCEDURE

A. Complete air balancing before commencing water balancing.

B. Perform test and balance systems in accordance with approved Submission Report.

3.5 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours duration to demonstrate to satisfaction of Architect that system(s) comply with requirements of plans and specifications, and that equipment and controls are functioning properly.

END OF SECTION

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SECTION 20 10 10
OUTSIDE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Outside Utilities, as indicated, in accordance with provisions of Contract Documents.

B. Definitions:
   1. Outside utility work: Work for following systems from a point 5 FT outside building wall.
      a. Fire protection system.
   2. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Compaction density test: Standard Proctor, ASTM-D698.

B. Owner will hire an independent soils laboratory to conduct in place moisture-density tests to ensure that work complies with this specification.
   1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.
   2. Contractor will pay additional cost if work is delayed due to Contractor's failure to notify Owner's agent as specified above.

C. Comply with aspects of "Safety Rules & Regulations for Excavation" as promulgated by State law for state in which excavation will occur.

D. Piping and Fittings: Section 20 11 00.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Fire protection drawings approved by authorities having jurisdiction.

B. Contract Closeout Information:
   1. Pressure test reports.

1.4 JOB CONDITIONS

A. Protect existing utilities and structures as indicated in Section 20 05 00.

B. Avoid overloading. Keep surcharge sufficient distance back from edge of excavation to prevent slides or caving. Maintain and trim excavated materials in such a manner to be as little inconvenience as possible to public and adjoining property owners.

C. Provide full access to public and private premises, to fire hydrants, at street crossings, sidewalks and other points as designated by Engineer to prevent serious interruption of travel.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Coating and sealants:
   1. Base:
   2. Optional:
      a. Koppers Industries.
      b. Sonneborn Building Products.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 PIPE AND FITTINGS

A. Pipe and Fittings:
   1. Meet or exceed applicable standards and Section 20 11 00.

B. Fire Protection Piping below grade:
   1. Cast iron pressure pipe or ductile iron pipe, lined with restrained Class D mechanical joints or push-on joints and cast iron fittings.

2.3 REACTION ANCHORS

A. Reaction Anchorage:
   1. Provide for pressure piping; concrete thrust blocking or joint harness.

B. Thrust Blocking:
   1. Sufficient mass of concrete, bearing on solid undisturbed ground, to resist hydraulic thrust at maximum pressures pipe will be subjected to, 150 PSI minimum.

C. Joint Harness:
   1. Steel straps or rods across joint securely anchored on pipe or other adequate anchorage to resist hydraulic thrust at maximum pressures pipe will be subjected to, 150 PSI, minimum.

D. Coal Tar Coating:
   1. Koppers Bitumastic No.50.

2.4 BACKFILL MATERIAL

A. Backfill Material:
   1. As approved by Engineer.
   2. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
   3. Moisture content at time of placement: 3 percent plus/minus of optimum moisture content.
      a. As tested in accordance with ASTM D698.

PART 3 - EXECUTION

3.1 EXCAVATING AND TRENCHING - GENERAL

A. Remove and dispose of materials determined by Engineer to be unsuitable.

B. Trench, backfill and compact for underground utilities.

3.2 TRENCH EXCAVATION

A. Excavate trenches by open cut method to depth indicated and necessary to accommodate work.
   1. Permission may be granted for tunnel work for crossing under crosswalks, driveways or existing utility lines.
   2. Such tunnels are limited to 10 FT in length.

B. Open no more than 300 LF of trench at one time, or less, as required by Engineer. Failure to comply may necessitate shutdown of entire project until backfilling is performed.

C. Carry rock excavations minimum of 12 IN below indicated grades and backfill to grade.

D. Avoid over-excavating below indicated grades unless required to remove unsuitable material.

E. Back-fill over-excavations in firmly compacted 6 IN lifts.

F. Trench size: Excavate only sufficient width to accommodate free working space.
1. Cut trench walls vertically from bottom of trench to top of pipe, conduit, or utility service.
2. Trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than following dimensions:

Overall Diameter of Utility Service	Excess Dimension
33 IN and less	16 IN

G. Brace and sheet trenches as soil conditions dictate. Do not remove until backfilling has progressed to a stage that no damage to piping, utility service, or conduit will result due to removal.

H. Keep trenches free of water.

I. Bedding:
1. Lay pipe directly on shaped subgrade.
2. No blocking permitted.
3. Form a continuous bearing with a minimum width of bearing equal to six-tenths (0.6) of outside diameter of pipe, for full length of pipe, except for portion at hole excavated for joint.

J. Form bell holes in trenches such that only barrel of pipe is firmly supported by bedding material.

3.3 REMOVAL OF EXISTING UTILITIES

A. Remove existing utilities as indicated.
1. Under new construction, plug and/or cap and protect existing utilities.
2. Pay fees for existing services capped at mains in street.

B. Plug abandoned sanitary and storm piping.

3.4 PIPE INSTALLATION - GENERAL

A. Pitch piping to drain.
1. Non drainage piping: 1 IN in 100 FT, minimum.

B. Install piping in accordance with Section 20 11 00.

C. Protect pipe from lateral displacement by using pipe embedment indicated.

D. Lay no pipe in water or in unsuitable weather or trench conditions.

E. Keep pipe and fittings clean inside; plug open end when laying is stopped.

F. Connections to existing pipe lines:
1. Use suitable fittings and perform work in appropriate manner.
2. Make connections at time and under conditions which will least interfere with service, and as directed by Owner.
3. Remove water or other fluids removed from lines during connection.
4. Paint metal surfaces exposed above grade as indicated in Section 09 91 13.

3.5 REACTION ANCHORAGE

A. Reaction Anchorage:
1. Use concrete thrust blocking where solid undisturbed ground of adequate bearing capacity is available.

2. Use joint harness in other cases.
3. If lack of solid undisturbed ground is due to careless or improper trench excavation, provide joint harness at no extra cost.

B. Coat underground metal surfaces not encased in concrete with coal tar coating.
1. Apply to clean, dry surface.
2. Allow first coat to dry hard; apply second coat.

3.6 FIELD QUALITY CONTROL

A. Test fire protection piping hydrostatically at 200 PSI for 2 hours, indicating no leakage in excess of NFPA-24 limits.
1. Provide 3 day notice to Fire Marshal prior to testing.

B. Perform backfill density tests as directed by Engineer.
1. Allow for one test per 100 FT of trench.

3.7 BACKFILLING

A. Do not backfill until tests are performed on system, and system complies with specified requirements.

B. Tamp backfill under and around pipe up to 24 IN above top of pipe in lifts not exceeding 8 IN loose thickness.

C. Backfill and compact remainder of trench in 8 IN lifts to density specified.

D. Tamp evenly on both sides of pipe to top of excavation or to a depth such that pipe will not be injured by subsequent compaction used to achieve required density.

E. Exercise care in backfilling operations to avoid displacing pipe joints either horizontally or vertically and to avoid breaking pipe.

F. Do not water flush for consolidation.

3.8 COMPACTION

A. Compact trench backfill in areas under paved roads, parking areas, sidewalks and other structures, to minimum of 95 percent Standard Proctor.

B. In locations where trench will not be under paved areas or structures, compact backfill to minimum 90 percent Standard Proctor.

3.9 INSTALLATION OF UNDERGROUND MARKING TAPE

A. Install underground marking tape above metallic outside utility lines as indicated on Drawings in accordance with manufacturer's instructions.

B. Install underground detectable marking tape above non-metallic outside utility lines as indicated on Drawings in accordance with manufacturer's instructions.

C. Allow 12 IN between tape and line, and install as close to grade level as feasible.

D. When lines are buried at indicated depths, install indicated width of tape.
1. 10 IN depth: 2 IN tape.
2. 20 IN depth: 3 IN tape.
3. 30 IN depth: 6 IN tape.
4. 40 IN depth: 9 IN tape.
5. 50 IN depth and greater: 12 IN tape.

END OF SECTION

SECTION 20 11 00
PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Pipe and Fittings, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Pressurized piping.
2. Nonpressurized piping.
3. Acid resistant piping.
4. High purity water piping.
5. Accessories:
   a. Dielectric fittings.
   b. Unions.

C. This specification lists a variety of piping that may be applicable to the project. Not all piping and fittings listed are applicable to the project, refer to appropriate Sections for project applicability.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Pipe and fittings to be ASTM labeled for rating specified.

B. Pipe and fittings to be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed NSF International.

C. Welder qualifications: Certified under requirements of ANSI/ASME-B31.1 Power Piping.

1.3 SUBMITTALS

A. Project Closeout Information:
1. Manufacturer of listed products.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cast Iron Pipe.
1. Base:
   a. Tyler.
2. Optional:
   a. AB&I.
   b. Charlotte Pipe.

B. Acid Resistant Polypropylene Pipe:
1. Base:
   a. R & G Sloane Manufacturing.
2. Optional:
   a. Enfield Industrial.
   b. Orion Industries.

C. Fittings, Mechanical Groove-end and Plain-end Pipe:
   1. Base:
      a. Victaulic Company of America.
   2. Optional:
      a. Anvil International, Inc.
      b. Grinnell.

D. Dielectric Waterway Fittings:
   1. Base:
      a. Perfection Corp. Victaulic Company of America.
      b. Grinnell.
      c. Victaulic.

E. Refer to appropriate specification sections for other system specific manufacturers.

F. Other manufacturers desiring approval comply with Section 01630.

2.2 PIPE

A. Black Steel Pipe:
   1. Seamless or welded steel pipe, ASTM-A53, standard weight unless otherwise indicated.
   2. For fire sprinkler service:
      a. The following Testing Standards and listed grades are acceptable:
         1) ASTM-A135, Grade B
         2) ASTM-A53, Grade B.
         3) ASTM- A795, Grade B.
      b. Weight: Schedule-40 unless otherwise indicated.

B. Copper Pipe:
   1. Seamless copper tubing, ASTM B88, Type-K or Type-L as indicated.
   2. Joints:
      a. Soldered: Use ASTM B32, 95 percent tin, 5 percent antimony solder, or Silvabrite 100.
      b. High temperature soldered: Use 1,000 DEGF solder.
      c. Ring seal crimped, where specified and permitted by authority having jurisdiction.
   3. 400 PSI fittings: Heavy wall type, Mueller "Steamline".

C. Cast Iron Soil Pipe:
   1. ASTM A74.
   2. Bell and spigot joints: Use neoprene gaskets when allowed by code.
   3. Gaskets: ASTM C564.
   4. Bear the collective trademark of the Cast Iron Soil Pipe Institute and be listed NSF International.

D. No Hub Cast Iron Pipe:
   1. CISPI 301 or ASTM A888.
   2. Mechanical joints:
      a. Conform to ASTM C1540: Join hubless pipe and fittings with heavy duty stainless steel couplings with neoprene gaskets.
      b. Approved manufacturers: Husky SD 4000, Clamp All 125 or MG Couplings.
   3. Gaskets: ASTM C564.
   4. Bear Cast Iron Soil Pipe Institute trademark and NSF International listed.

E. Ductile Iron Pipe:
   1. Centrifugally cast, ANSI/AWWA-C151/A21.51, lined and coated.
   2. Joints:
      a. Gasketed mechanical joints: ANSI/AWWA-C111/A21.11.
         1) Gaskets: ANSI/AWWA-C111/A21.11.
      b. Cut grooved.

F. Cast Iron pressure pipe:
1. ANSI/AWWA-C105/A21.5, lined and coated.
2. Thickness class: 22.
   a. Exception: When depth of cover exceeds 8 FT, use thickness class 23.
3. Joints: Use mechanical or push-on joints below grade.
4. Mechanical or push-on joints for water: ANSI/AWWA-C111/A21.11.
5. Mechanical joints for fuel gas piping: ANSI-B31.2.
6. Gaskets: Suitably formed of high quality vulcanized rubber, made to exact dimensions, and in form of a solid ring, with durometer hardness of approximately 85; for joint rating of 350 PSI internal liquid pressure, minimum.

G. Shop Coating and Lining for ductile and cast iron pipe:
1. Cement lining: ANSI/AWWA-C104/A21.4, except lining thickness may be reduced to 0.5 ANSI specified thickness for "Enameling" coating.
2. Rust preventative: Non-Ox-Id 558.
3. Bituminous coating: Manufacturer's standard, minimum 1 mil thick.
4. Provide interior surfaces of ductile iron and cast iron pipe and fittings with cement lining.
5. Shop coat flange faces with rust preventative compound.
6. Shop coat other surfaces of ductile iron and cast iron pipe and fittings with bituminous coating.

H. Acid Resistant Polypropylene Pipe:
1. DWV, Schedule-40.
2. Polypropylene: ASTM D635; rated SE-O in accordance with ANSI/UL-94.
3. Provide in 10 or 20 FT lengths.

2.3 FITTINGS AND COUPLINGS

A. Steel Pipe Fittings:
1. Socket welding fittings: ANSI/ASME-B16.11 and ASTM A234.
2. Butt welding fittings: ANSI/ASME-B16.9, ANSI/ ASME-B16.25 and ASTM A105.
3. Flanged fittings: ANSI/ASME-B16.5 and ASTM A105.
4. Flange bolts: ASTM A193 Grade B7.
5. Gaskets: Spiral wound metallic.

B. Cast Iron Pipe Fittings:
1. Drainage fittings: Coated or galvanized, ASTM A74.
2. Threaded fittings: ANSI/ASME-B1.20.1 and ANSI/ASME-B16.4, Class 125.
3. Threaded drainage fittings: ANSI/ASME-B1.20.1, ANSI/ASME-B16.12 and ASTM A126.
4. Flanged: ANSI/ASME-B16.1, Class 125.

C. Copper Pipe Fittings:
1. Wrought copper fittings: ANSI/ASME-B16.22.
2. Cast brass fittings: ANSI-B16.18.
3. Flared tubing fittings: Use only on annealed pipe.
4. Cast flanged fittings: ANSI/ASME-B16.24, Class 150.
5. 400 PSI fittings: Heavy wall type, Mueller "Steamline".

D. Ductile Iron Pipe Fittings:
1. ANSI/AWWA-C110/A21.10.
2. Gasketed mechanical joints: ANSI/AWWA-C111/A21.11.
3. Laying Length, AWWA fittings: Short body dimensions.
4. Flanged fittings: ANSI/ASME B16.5.
5. Thickness of iron: Not less than for ductile iron pipe with additional thickness as required for proper reinforcement of branches for tees and crosses.

E. Cast Iron Pressure Pipe Fittings:
   1. ANSI/ASME B16.1 and ANSI/AWWA C111/A21.11 mechanical joint type, suitable for minimum working pressure of 150 PSI plus 100 PSI surge pressures.
   2. Laying length:
      a. AWWA fittings: Short body dimensions.
      b. ANSI mechanical joint fittings: ANSI/AWWA-C110/A21.10.
      c. Others: ANSI/ASME-B16.1.
   3. Thickness, 6 through 12 IN: Not less than for cast iron pipe with additional thickness as required for proper reinforcement of branches for tees and crosses.

F. Acid Resistant Polypropylene Pipe Fittings:
   1. DWV, Schedule-40.
   2. Material: Flame retardant polypropylene, same material as pipe.
   3. Fusion joints.

G. Dielectric Fittings:
   1. General:
      a. Standard product for prevention of galvanic corrosion.
   2. Dielectric union:
      a. Ground-joint union with end connections of different material.
         1) End connection materials: Compatible with respective piping materials.
         2) Gasket and inert, non-corrosive thermoplastic sleeve shall electrically isolate end connections from each other.
   3. Dielectric waterway fitting:
      a. ASTM A53 Schedule-40, hot dip galvanized, steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
      b. Threaded or threaded X rolled grooved connections.
      c. Victaulic, "Clearflow".

H. Mechanical Groove-end Couplings and Fittings:
   1. Couplings:
      a. Malleable iron, ASTM A47 or ductile iron, ASTM A536.
      b. Gaskets: EPDM Grade-E conforming to ASTM D2000 for water services up to 230 DEGF.
      c. Bolts and nuts: ASTM A183.
         1) Heat treated plated carbon steel, track-head.
         2) Minimum tensile strength: 110,000 PSI.
   2. Fittings:
      a. Malleable iron, ASTM-A47 or ductile iron, ASTM-A536.

I. Unions.
   1. Same type, pressure rating and material as piping.
   2. Flanges: Raised face type of same type, pressure rating and material as piping.
   3. Unions in copper pipe:
      a. 2 IN and smaller: Use wrought copper solder joint copper to copper unions.
      b. 2-1/2 IN and larger: Use brass flange unions.
   4. Dielectric unions: See Dielectric fittings:

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with ANSI/ASME B31.9 for pressure piping installations.
   1. Install piping without "bull-head" fittings.

B. Flush out water piping systems with clean water prior to adding treatment.

C. In general, make connections to components in piping systems with 3-elbow swing joints to allow for movement.
   1. Movement includes but not limited to expansion, contraction, seismic, and equipment vibration isolation.

3.2 PIPING

A. Install piping parallel to building walls at such heights as not to obstruct portion of window, doorway, stairway, or passageway.
   1. Where interference develops in field, offset or reroute piping as required to clear such interferences.
   2. Consult Drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details and report discrepancies to Architect, before installing piping.

B. Pitch Piping to Drain:
   1. Minimum pitch of 1 IN in 100 FT (except drainage piping).
   2. Make piping and equipment drainable.
   3. Accomplish pipe drainage using drain valves located on equipment and fixtures or separate drains.
   4. Drains: See Section 20 05 19.

C. Factory cut and thread nipples from seamless stock.
   1. Use nipples of same material as pipe with which they are used.
   2. Do not use close nipples except where such use is unavoidable.
   3. Use Schedule-80 seamless pipe for close nipples and nipples of pipes 3/8 IN or smaller.

D. Provide backing and sleeves required in walls or floors for setting of fixtures or equipment.

E. Where transition occurs from sweated fittings (as at connection to fixture supplies, etc.), provide rigid anchorage so that no strain will be placed upon tubing.

3.3 JOINTS

A. Threaded Joints:
   1. Cut piping carefully, ream, thread and work into place without springing.
   2. Use a small amount of prepared pipe thread lubricant on outside threads only.
   3. Provide in accordance with ANSI/ASME-B1.20.1.

B. Flanged Joints:
   1. Take care to ensure that there is no restraint on opposite end of pipe or fittings which would prevent uniform gasket compression or cause unnecessary stress in flanges.
   2. Keep one flange free to move in any direction while flange bolts are being tightened.
   3. Do not pack or assemble bell and spigot joints affected by flanged joints until such flanged joints have been tightened.
   4. Tighten bolts gradually and at a uniform rate, so that gasket compression is uniform over entire area of gasket.

C. Mechanical Joints:
   Assemble in accordance with instructions and recommendations of pipe manufacturer.
   Clean joint surfaces and lubricate with soap solution or water soluble lubricant immediately before joint is assembled.
   Groove-end and plain-end joints:
   a. Use mechanical joint system only with pipe meeting joint manufacturer's requirements.
      1) When joint manufacturer's pipe requirements exceed specified requirements, provide pipe that meets joint manufacturer's requirements.
   b. Prepare pipe and install system in accordance with joint manufacturer's instructions and recommendations.

D. Use dielectric waterway fittings for connections between dissimilar metals.

3.4 UNIONS

A. Provide a union between valves, at connection to each fixture, device or item of equipment, and elsewhere as required to facilitate installing, servicing, making up and disconnecting piping.
   1. Install each union to facilitate removal of parts, equipment or fixtures for inspection or cleaning.
   2. Install in a position which will permit device, fixture or part to be removed without disconnecting piping except unions.

B. Install unions in accordance with Fluid Controls Institute (FCI).
   1. Grooved piping systems:
      a. Grooved type couplings may serve as unions.
   2. Make connections between couplings and flanged equipment with slip-on flanges and a grooved nipple, or groove-to-flange adapter.
   3. Welded piping systems:
      a. Where flanged end-service valves are used at equipment connections, flange unions will not be required.
      b. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
      c. Flanged cast iron ells may be used for connections between pumps, strainers, check valves and other flanged equipment.

C. Install dielectric fitting at each piping joint and equipment connection between ferrous and non-ferrous materials.

3.5 PIPING EXPANSION

A. Install piping to allow thermal expansion and contraction without damage to piping, equipment or structure.
   1. Use loops or expansion joints where necessary and where detailed.
   2. Provide pipe guides at loops as indicated.

B. Where screwed piping is used for soil, waste or vent risers, or downspouts, use expansion joints at intervals to allow expansion movement.

3.6 WELDED STEEL PIPING

A. Where welded piping is specified, make welds by oxy-acetylene or electric process in accordance with ANSI/AWS D10.12 and ANSI/AWWA C206.
   1. Welding rods: Grade recommended for purpose by manufacturer; each rod stamped with manufacturer's name and identification.

B. Line Welds:
   1. Single V-butt type.
   2. Mill or machine bevel pipe at 37.5 degrees to within 1/16 IN of inside wall, except that in field, limited amount of pipe may be flame beveled.
   3. Pipe with a wall thickness of 3/16 IN or less need not be beveled but may be welded by melting down into, and building up over abutting ends.
   4. Separate abutting ends of joints before welding to permit complete fusion to bottom without overlapping.
   5. Tack in two or more points to maintain alignment, and fusion weld.
   6. Weld continuously around pipe.

C. Make welds of sound weld metal, thoroughly fused into ends of pipe, and to bottom of vee.
   1. Build in excess of pipe wall to give reinforcement of 0.25 pipe wall thickness.
   2. Weld metal shall present a gradual increase in thickness from surface of pipe to center of weld.
   3. Minimum weld width: 2.5 times thickness of pipe wall.

D. Use welding ells at turns in welded lines except where pipe bends are indicated or are required for flexibility.

E. Mitered ells will not be permitted.

F. Do not weld pipe couplings in place of welding fittings for branch connections.

G. Weld-O-Lets and Thread-O-Lets:
   1. Scribe and cut openings in main pipes for welded branches accurately taking care to remove plug and cuttings from main pipe.
   2. Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by Weld-O-Let manufacturer.
      a. Partially filled fillets not acceptable.

H. Cut openings into pipe for welded connections accurately to give carefully matched intersections.

I. Make welded fittings of same material with same pressure and temperature rating as pipe with which they are used.

J. Make flanged connections to control valves, pump suction, and specialties with ANSI standard welding neck flanges.
   1. Other flange connections may be made with slip-on flanges provided they are seal welded on inside.

K. Fuse fillet welds for flanges or fittings into pipe and plate for minimum distance of 1.5 times pipe wall thickness and depth of weld of 1.25 times pipe wall thickness.

3.7 THREADED STEEL PIPING

A. Branch connections to screwed piping may be made with Weld-O-Lets or Thread-O-Lets.

B. Do not weld pipe couplings in place of welding fittings for branch connections.

3.8 DUCTILE IRON AND CAST IRON PRESSURE PIPING

A. Perform cutting without damage to pipe or to cement lining.
   1. Make pipe cuts smooth, straight and at right angles to pipe axis.
   2. Use approved type mechanical pipe cutters.
   3. In locations where use of mechanical cutters would be difficult or impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will not cause damaging impact or shock.

B. Use equipment, tools and methods in handling and laying pipe and fittings which prevent damage.
   1. Hooks inserted in ends of pipe shall have broad, well padded contact surfaces.

C. Replace pipe and fittings in which cement lining has been broken or loosened.
   1. Where damaged areas are small and readily accessible, lining may be repaired, if Architect approved.

D. Repair pipe coating which has been damaged before installing pipe.

E. Make connections between below ground piping and above ground piping with a flanged spigot adapter.
   1. Hold spigot piece in place with bolts on 2 sides of flanges between mechanical joint and flange connector.

F. Comply with AWWA C600 for installation.

G. For corrosion protection encase underground ductile iron and cast iron pipe including joints in a loose 8 MIL thick polyethylene tube or sheet enclosure.
   1. Install polyethylene pipe enclosure in accordance with ANSI/AWWA-C105/A21.5 Method A, B or C.

3.9 CAST IRON DRAINAGE PIPING

A. Lay underground pipe on undisturbed earth excavated to provide firm bearing on at least 0.333 of pipe circumference for full length, with bell holes cut out.
   1. Where excavation has been carried too deep, place a layer of sand well tamped to bring pipe to proper grade.
   2. Where fill or unsound earth is encountered, place a layer of 2500 PSI concrete to properly bed pipe.

B. Bell and Spigot Joints:
   1. Install neoprene gaskets in accordance with manufacturer's recommendations.
   2. Furnish sufficient lubricant to provide a thin coat on each spigot end.
   3. Use lubricant that is non-toxic, imparts no taste or odor to conveyed liquid, and has no deleterious effect on rubber gasket, with consistency so that it can be easily applied to pipe in hot or cold weather and will adhere to either wet or dry pipe.

C. Threaded Joints:
   1. Clean cut, American National taper pipe threads.
   2. Ream pipe ends to full pipe size and remove burrs, chips, cuttings before making up.
   3. Pipe joint cement permitted on male threads only.

3.10 COPPER PIPING

A. Brazed High Temperature Soldered Joints:
   1. Take care to avoid annealing of pipe material.
   2. For pipe sizes 2 IN and larger: Use a circular torch such as Circa Torch by Cedarberg Industries, for soldering joints.

B. Solder: Lead-free.

3.11 POLYPROPYLENE PIPING

A. Make thermal welded joints in accordance with manufacturer's recommendations and instructions.

END OF SECTION

SECTION 21 10 00
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and design services for Fire Protection Systems in accordance with provisions of Contract Documents.

B. Fire Protection Systems Included:
   1. Water based:
      a. Standpipe-and-hose system, manual.
      b. Wet-pipe sprinkler system, automatic.
   2. Products:
      a. Pipe, fittings, and supports.
      b. Alarm and signal devices.
      c. Backflow protection devices.
      d. Fire alarm system control panel.
      e. Fire department connections.
      f. Fire department valves.
      g. Fire system valves.
      h. Manual valves.
      i. System accessories.
      j. Sprinklers.
      k. Flexible sprinkler hose fittings.

C. Completely coordinate with work of other trades.

D. Completely coordinate with the existing conditions, whether the area(s) are renovated by other trades or not. Refer to Section 20 05 05.

1.2 DESCRIPTION OF WORK

A. The contractor shall provide a complete sprinkler system and standpipe system design including mains, branch lines, sprinkler head locations, hangars, sway bracing, notes and calculations and hydraulic calculations for the fire sprinkler system and standpipe system. All information contained within any associated project drawings is provided for design intent only to show the intended scope of work, and the contractor is responsible to provide construction drawings in accordance with all codes and standards.

B. The entire building shall be provided with a new approved fire protection system(s), and coordinated throughout the building scope areas of the project as shown on the drawings. Except where systems are noted to remain, all existing fire protection system(s) shall be removed and replaced with new.

C. The new fire protection system(s) shall be combination wet pipe, with automatic sprinklers throughout, and manual standpipes reliant upon the fire department connection for hose stream pressure. Fire suppression for computer rooms shall be the standard sprinkler system.

D. Existing automatic wet sprinkler fire protection systems to remain and to be (re)connected.
   1. Keen Hall.
   2. Metabolomics laboratories 2215 & 2215B, and offices 2215C & 2215D.
   3. Office 2205 and Meeting room 2209.

E. Provide all material and labor and perform all engineering and operations necessary for the layout and installation of complete and operable fire protection systems as specified herein.

F. This contractor shall be completely responsible for the design, layout, installation, testing and certification of the fire protection systems, in accordance with the applicable codes and for acceptance of the system by the authority.

G. Furnish and install all necessary equipment and materials including pipe, valves, fittings, sprinklers, and accessories necessary to provide a complete and approved fire protection system.

H. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer.

I. Fully coordinate work with other trades working on the project. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. Refer to mechanical drawings for ducting arrangements and above ceiling space coordination purposes. The location of the sprinklers and sprinkler piping shall be established after the plumbing, electrical and HVAC trades have established the location of their system components. The sprinklers and sprinkler system piping shall be coordinated around the other trades, listed above. Submittals shall indicate that coordination has taken place. If during or after the installation of the sprinkler system, it is found that coordination with other trades was not done by the sprinkler contractor, the sprinkler contractor shall rework the sprinkler system, in order to achieve the necessary coordinated installation, while still meeting the design requirements listed within this specifications.

1.3 QUALITY ASSURANCE

A. Use only new material of first class construction, designed and guaranteed to perform service required.

B. Provide fully operational systems.

C. Provide complete fire protection systems as described in the Contract Documents and according to criteria of authority having jurisdiction (AHJ) and the Owner's insurance carrier.
   1. Where system requirements as described in the Contract Documents exceed those of the AHJ, meet requirements of both.
   2. Where discrepancies exist among the AHJ, Owner's insurance carrier, and Contract Documents, the most stringent requirements shall take precedence.

D. Provide seismic bracing in accordance with Section 20 05 48.

E. Addition, deletion, or relocation of existing sprinklers, and rerouting of existing pipe may be necessary.

F. Authorities Having Jurisdiction:
   1. UCR Campus Fire Marshal.
   2. Code Enforcement Agencies.
   3. State Fire Marshall's Office.
   4. State Insurance Office.
   5. Water Supply Authority.

G. Owners Insurance Carrier.

H. Referenced Criteria (applicable as referenced by AHJ and Owner's Insurance Carrier):
   1. Latest edition of referenced criteria applies unless an earlier edition is specifically indicated by the AHJ and Owner's insurance carrier.
   2. CBC 2016 and CFC 2016 with State Amendments.
   3. National Fire Protection Association (NFPA), Standard 13 and 14.
   4. Underwriter's Laboratories (UL).
   5. Factory Mutual Engineering Commission (FM).

I. Designer Qualifications:
   1. The fire protection system shall be designed by a minimum NICET Certified Level III Sprinkler Designer.
      a. If required by state regulations, a Professional Fire Protection Engineer shall seal drawings submitted to the AHJ.
      b. Drawings and hydraulic calculations shall include certification NICET Certified Level III Designer, signature and registration number of the Professional Fire Protection Engineer if require by state regulations.
      c. The designer shall be responsible for understanding the construction of the building which includes but not limited to: building construction type, ceiling heights, beam depths, obstructions, other disciplines layouts (e.g. mechanical, electrical, etc.), and other features of the building that are required in order to provide a fire protection system that is fully code compliant.

J. Installer Qualifications:
   1. Fire protection systems shall be installed by a minimum NICET Level II technician and under the direct supervision of the NICET Level III designer indicated above.
   2. Fire Protection Installer shall be licensed, and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.
   3. Use workmen skilled in this trade.
   4. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS D10.9.
   5. Installation of the following items/systems shall be done by authorized representatives of respective manufacturers:
      a. Fire system valves.

K. Design requirements:
   1. Design fire protection system(s).
   2. Design shall be stamped with valid seal of a licensed professional engineer.

L. Piping and Fittings: Section 20 11 00.

M. Outside Utilities: Section 20 10 10.

1.4 SUBMITTALS

A. Product Data:
   1. Piping, fittings, and devices.
   2. Backflow protection devices.
   3. Standpipe-and-hose system.
   4. Wet-pipe sprinkler system.

B. Project Information:
   1. Submit detailed design data and complete layout of fire protection systems approved by authorities having jurisdiction (including Owner's insurance carrier) and prepared in accordance with the requirements for Working Plans described in applicable NFPA standards.
      a. Include calculations prepared in accordance with the requirements for Hydraulic Calculations described in applicable NFPA 13 standard.
   2. Architect reviews for project information and general conformance with contract documents.

C. Contract Closeout Information:
   1. Letter, with Owner acceptance signature, stating spare parts and extra materials per NFPA requirements have been delivered.
   2. Operation and Maintenance Data.
   3. Owner instruction report.
   4. Test reports:

a. Certification that tests as indicated in FIELD QUALITY CONTROL (Part 3) have been successfully completed and approved by authorities having jurisdiction.

1.5 JOB CONDITIONS

A. Arrange and pay for permits, fees and inspections required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Alarm and Signal Devices:
   1. Base:
      a. Viking.
   2. Optional:
      a. Federal Signal.
      b. Fire-Lite Alarms/Notifier.
      c. Potter Electric Signal.
      d. Potter Roemer.
      e. Simplex Access Controls.
      f. United Electric Controls.

B. Alarm-Test Device:
   1. Base:
      a. Viking.
   2. Optional:
      a. Grinnell.
      b. Victaulic of America.
      c. AGF Manufacturing Inc.

C. Backflow Protection Devices:
   1. Base:
      a. Cla-Val.
   2. Optional:
      a. Febco.
      b. Hersey Measurement.
      c. Watts Control Valves.
      d. Wilkins Regulator.
      e. Ames Co./Fluid Controls Systems.

D. Fire Department Connections, Fire Department Valves:
   1. Base:
      a. Elkhart Brass.
   2. Optional:
      a. Croker West.
      b. Grinnell.
      c. JL Industries.
      d. Larsen's Manufacturing.
      e. Potter Roemer.
      f. Seco.
      g. Waterous.

E. Fire Protection Systems, Water Based:
   1. Base:
      a. Viking.
   2. Optional:
      a. Central Sprinkler.

b. Firematic Sprinkler Devices.
c. Globe Fire Sprinkler.
d. Potter Roemer.
e. Star Sprinkler.

F. Sprinklers:
1. Base:
a. Viking.
2. Optional:
a. Firematic Sprinkler Devices.
b. Globe Fire Sprinkler.
c. Reliable Automatic Sprinkler.
d. Star Sprinkler.

G. Flexible Sprinkler Hose Fittings
1. Base:
a. Victaulic, AquaFlex
2. Optional:
a. Flexhead Industries, Inc.

H. Submit other pipe materials, joining methods, and equipment not specified, but accepted by applicable NFPA standards and approved by Authority Having Jurisdiction, in accordance with Section 01630.

2.2 DESIGN REQUIREMENTS

A. Design fire protection system(s).
1. Design shall be stamped with valid seal of a licensed Professional Fire Protection Engineer.
2. Obtain water supply fire flow test from the Campus Fire Marshal prior to designing systems.
3. Pre-design fire flow test: Daart Engineering Co., November 15 2019.
a. Flow hydrant location: South-east corner of Eucalyptus Dr & driveway.
b. Gauge hydrant location: South-west corner of Eucalyptus Dr & Picnic Hill Rd.
c. Gauge hydrant elevation: 1115 FT, estimated and to be determined.
4. Compare flow test results to those listed below, and use lowest pressure of the two to design systems.
a. Static pressure: 110 PSIG.
b. Residual pressure: 96 PSIG.
c. Flow: 1430 GPM.
d. Pitot pressure: 72.5 PSIG.
e. Nozzle size: 2.5 IN.
f. Butt Coefficient: 0.9.
5. Design systems using adjusted water supply curve:
a. Adjust the flow test water supply curve to correspond with the low hydraulic grade line as provided by the water supplier.
6. Designs shall include a minimum safety allowance of 10 PSIG below the adjusted water supply curve.
7. Design to 90% of the available water supply.

2.3 PIPE, FITTINGS, AND SUPPORTS

A. Pipe and Fittings - General:
1. Meet or exceed applicable NFPA standards and Section 20 11 00.
2. Working pressure: Not less than 175 PSI.
3. The following are not permitted:
a. Lightwall and Schedule 5 or 10 pipe.
b. Plain end, pressure fit type fittings.
c. Hole cut mechanical tee fittings.
4. Fittings: Galvanized where galvanized piping is used.

5. Corrosion Resistance Ratio (CRR) of all pipe used: equal to or greater than one.

B. Above ground pipe normally containing water:
   1. Examples: Wet-pipe and standpipe-and-hose fire protection systems.
   2. Black steel, Schedule-40:
      a. Threaded joints.
      b. Welded joints.
      c. Mechanical joints:
         1) Cut or rolled groove type.
         2) Mechanical locking (push-on) type.

C. Pipe, below ground:
   1. Same as outside utility fire protection piping.
      a. See Section 20 10 10.

D. Fittings:
   1. Threaded:
      a. Black cast iron, Class 150.
      b. Black malleable iron.
      c. Galvanized malleable iron.
   2. Flanged:
      a. Black cast iron, short body, Class 125.
      b. Galvanized malleable iron.
      c. Gaskets: Full face of 1/8 IN minimum red sheet rubber.
      d. Flange bolts: ANSI-B18.2.
         1) Hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated.
   3. Welded:
      a. Black steel, standard weights.
   4. Mechanical: ASTM-A47.
      a. Malleable iron, 500 PSI working pressure.
      b. Coupling gasket material: Butyl rubber.
      c. UL listed.
      d. Approved by FM, NFPA-13, and NFPA-14.

E. Pipe Supports:
   1. All-purpose type, UL listed and FM approved.
   2. Manufacturer: Comply with Section 20 05 29.
   3. Supports, hanger rods, inserts and clamps acceptable to NFPA.

2.4 ALARM AND SIGNAL DEVICES

A. UL listed and FM approved.

B. Coordinate electrical requirements with electrical installer.

C. Alarm Devices:
   1. Alarm pressure switch:
      a. Shall signal Fire Alarm System Control Panel upon sensing change of pressure in fire system valve.
         1) Switch shall automatically reset when pressure returns to normal.
      b. Service: Normal.
   2. Local alarm devices:
      a. General:
         1) Provide local alarm on systems of sufficient size as indicated in NFPA-13.
         2) Use alarm bell and visible light alarm on electrically operated supplemental fire detection (valve release) systems.
         3) Devices shall be weatherproof.

b. Alarm bell, electric:
   1) Shall provide audible alarm signal upon activation of fire protection system.
   2) 10 IN weatherproof bell.
   3) Provide backer plate to prevent birds and insects from entering inside of bell housing.
c. Visible light alarm:
   1) Semi-flush, 24 Volt DC.
   2) Tamper-resistant white lexan lens, with "FIRE" imprinted in red.
   3) Light shall be mountable on either ceiling or wall.

D. Signal Devices:
1. Valve tamper switch: Furnished under Electrical Specification Divisions.
2. Valve tamper switch:
   a. Shall signal Fire Alarm System Control Panel upon valve movement.
3. Water flow detector:
   a. Shall signal Fire Alarm System Control Panel when water flows in system.
   b. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
   c. 175 PSI rated.
   d. Suitable for working pressure of 150 PSI with sensitivity adjusting screw.

2.5 BACKFLOW PROTECTION DEVICES

A. Provide on water supply at location indicated on drawings to prevent contamination of potable water system.

B. Corrosion resistant materials.

C. Totally rebuildable.

D. Flanged ends.

E. Rating: Water at 175 PSI working pressure and between 33 to 110 DEGF.

F. Provide OS&Y inlet and outlet isolation valves.

G. Provide four test cocks.
1. Provide No. 1 test cock on inlet valve.

H. Approved by authority having jurisdiction.

I. UL listed and FM approved.

J. Double Check Detector:
1. Two independently operating check valves.
2. Bypass line with two independently operating check valves, water meter, three test cocks, and outlet shutoff valve. Bypass shall allow 8-10 GPM of flow before main-line assembly opens.

2.6 FIRE ALARM SYSTEM CONTROL PANEL

A. Fire alarm system control panel: Provided under Electrical Specification Divisions.

2.7 FIRE PROTECTION SYSTEMS, WATER-BASED

A. Standpipe-and-Hose Fire Protection System:
1. Class I:
   a. Standpipes, fire department connections, and fire department valves.

B. Wet Pipe Fire Protection Sprinkler System:
1. Description: Automatic system shall employ closed sprinklers attached to a piping system filled with pressurized water.

2. Reduction in area of operation when use of quick response sprinkler heads as defined in NFPA 13 will not be allowed.
   a. Normal operation:
      1) Actuation of sprinkler allows water to flow through actuated sprinkler.
      2) Water flow in zone sends signal to Fire Alarm System Control Panel.
   b. Failure of sprinkler allows water to flow through sprinkler.
      1) Water flow in zone sends signal to Fire Alarm System Control Panel.

2.8 FIRE DEPARTMENT CONNECTIONS

A. Components and assemblies UL listed and FM approved.

B. Minimum 175 PSI non-shock cold-water working pressure.

C. Inlet threads for connections to fit local fire department standards.

D. Outlet threads for hydrants to fit local fire department standards.

E. Fire Department Siamese Connections.
   1. Outside type.
   2. Inlet:
      a. Quantity:
         1) Four.
      b. Size:
         1) 2-1/2 IN.
      c. Fittings:
         1) Brass snoots, brass pin-lug swivels, brass pin-lug plugs, chains, and gaskets.
   3. Outlet:
      a. Quantity:
         1) One.
      b. Size:
         1) 6 IN.
   4. Finish:
      a. Satin brass.
   5. Raised lettering:
      a. "AUTOSPKR STANDPIPE".
   6. Connection style:
      a. Free-standing, brass sleeve, brass escutcheon plate, and drop clappers.
   7. Provide as indicated.

2.9 FIRE DEPARTMENT VALVES AND FIRE CABINETS

A. Components and assemblies UL listed and FM approved.

B. Outlet threads shall match local fire department standards.

C. Valves:
   1. Minimum 175 PSI non-shock cold-water working pressure.

D. Cabinet:
   1. For use with fire department valves.
   2. Recessed-cabinet mounting box: 18 or 20 GA steel with baked white enamel inside.
   3. Door frame: For use with recessed and semi-recessed cabinets.
      a. 16 or 18 GA steel.
   4. Door:
      a. Continuously hinged 20 GA steel.

E. Fire Department Valves:
   1. General:
      a. 2-1/2 x 2-1/2 IN valve.

b. 2-1⁄2 x 1-1⁄2 IN reducer.
c. Cap and chain.
d. Pattern: Straight or angle.

2. FDV, Fire department valve without cabinet:
   a. Finish: Polished brass.
3. FVC-1, Fire department valve with cabinet:
   a. Cabinet mounting:
      1) Recessed.
   b. Door style:
      1) Full glass panel with wire insert set in steel door with lever handle cam latch.
   c. Cabinet and door finish:
      1) Prime painted.
      2) Anodized, white.
   d. Valve finish:
      1) Rough brass.
   e. Mark: "FIRE DEPARTMENT VALVE".

2.10 FIRE SYSTEM VALVES

A. UL listed and FM approved.

B. Body: Ductile or cast iron.

C. Pressure rating: 175 PSI non-shock cold-water working pressure.

D. 2 IN and smaller: Threaded.

E. 2-1/2 IN and larger: Flanged or grooved.

F. Trim to meet NFPA requirements.

G. Trim to meet performance as indicated in descriptions of fire protection systems.

2.11 MANUAL VALVES

A. See Section 20 05 23.

B. Isolation Valves:
   1. Gate valves:
      a. 2 IN and smaller: V-49.
      b. 2-1/2 IN and larger: V-50.

C. Check Valves 2-1/2 IN and larger: V-53 or V-54.

D. Automatic Ball Drip Valve:
   1. 1/2 IN straight or angle cast-brass ball drip shall close against pressure.
   2. When pressure drops, valve shall open to drain pipe.

2.12 SPRINKLERS

A. UL listed sprinklers of style and type required for service indicated.

B. Sprinklers in systems sized from pipe schedules shall have 1/2 IN nominal orifices.

C. Finish of exposed parts: As indicated.

D. Sprinkler types: Metallic fusible link or glass bulb.

E. Sprinkler Styles:
   1. Upright:
      a. Finish: Standard bronze.
   2. Pendant:
      a. Finish: Standard bronze.

3. Pendant with escutcheon:
   a. Finish: Chrome.
4. Recessed pendant:
   a. Deflector: 1 to 1-1/2 IN below finished ceiling.
   b. Escutcheon: Two-piece with 1/2 IN adjustment.
   c. Removal of escutcheon and ceiling tile shall not disturb sprinkler or drop assembly.
   d. Finish: Chrome.
5. Flush pendant:
   a. Escutcheon: 1/2 IN adjustment.
   b. Finish: Chrome.
6. Tamper-proof flush pendant:
   a. Escutcheon: 1/2 IN adjustment.
   b. Specifically designed to prevent occupant from using sprinkler to injure themselves or others.
   c. Finish: Chrome.
7. Concealed pendant:
   a. Ceiling plate flush with finished ceiling.
   b. Housing: 1/2 IN adjustment.
   c. Finish: White.
8. Horizontal sidewall:
   a. Finish: Chrome.
9. Horizontal sidewall, extended coverage:
   a. Finish: Chrome.
10. Exterior:
    a. Finish: Corrosive resistant.

2.13 FLEXIBLE SPRINKLER HOSE FITTINGS:

A. Hose fittings – general
   1. Hose fitting shall be stainless steel for use in connecting sprinkler heads in commercial suspended ceilings. A bracket attaches to the ceiling grid for supporting the hose.
   2. Hose fittings shall be braided stainless steel, hose fittings and accessories shall be FM 1637 approved.

2.14 SYSTEM ACCESSORIES

A. Alarm Test Device:
   1. Optional replacement for alarm test loop.
   2. Single device or unit that provides visual verification of water flow in a fire sprinkler system and allows for draining of all or a portion of that system.
   3. Contains sight glass, inspector test valve, auxiliary drain valve and test orifice.
   4. UL listed and FM approved.

B. Pressure Gauges:
   1. UL listed and FM approved.
   2. See Section 20 05 19.

C. Spare Parts:
   1. Tools:
      a. Furnish one emergency rubber ball shutoff on long handle to be used for temporary closing of sprinkler after fire has been extinguished.
      b. Furnish testing apparatus capable of producing the heat or impulse necessary to operate supplemental fire detection systems in manner recommended by manufacturer of detection system.
   2. Sprinkler cabinet, Wall mounted:
      a. Provide spare sprinklers of each type and sprinkler wrench for each type in quantities required by NFPA-13.

D. Sprinkler Guards:
   1. UL listed.
   2. Heavy duty welded wire.
   3. Red baked enamel finish.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate with other trades to ensure adequate space for equipment and piping placement.

B. Review plans, specifications and shop drawings of other trades to coordinate work.

C. Do not begin installation until after Agency approvals have been submitted to Architect.

D. Test systems in accordance with System Standards, manufacturers' instructions, and applicable NFPA publications.

E. Install systems in accordance with System Description, manufacturers' instructions, and approved shop drawings.
   1. Modifications to system design or arrangement after approval of drawings may only be made after receiving written approval of Architect and authority(ies) having jurisdiction.
   2. Such modifications do not include minor relocations in piping or sprinkler placement.
   3. Make revisions in accordance with NFPA.

F. Maintain fire and smoke ratings where mechanical items penetrate fire and fire/smoke rated building elements.

G. Field quality control: Give advance notice and arrange for field tests and inspections by authority(ies) having jurisdiction.

3.2 PIPING, SPRINKLERS, AND SUPPORTS

A. Piping - General:
   1. Install sprinkler piping within first 6 IN of space under floor construction.
      a. Where conditions of construction require piping installation at a lower elevation, route piping to avoid interference with work of other trades.
   2. Avoid interconnecting standpipes through sprinkler system piping.
   3. Offset, crossover and otherwise route piping to install system in available space.
      a. Not every offset is indicated.
   4. Install chromed escutcheons on finished-area sides of pipe penetrations.
      a. Secure escutcheons so they make contact with floor, wall, or ceiling.
   5. When risers are concealed, provide wall flange at each FDV and within cabinets.
   6. Pitch branch lines, cross mains, feed mains and risers to drains.
   7. Paint all fire sprinkler piping red enamel in accordance with Section 09 91 23.
   8. Flush outside fire-main piping prior to connecting to inside system.

B. Piping – Inspection:
   1. Welding shall be inspected in accordance with California Building Code Chapter 17.

C. Sprinklers - General:
   1. Install sprinklers to provide and maintain minimum 18 IN clear between bottom of deflector and top of storage, files, shelving, and cabinets.
   2. Standard-application temperature rating:
      a. Sprinkler type:
         1) Glass bulb: 155 DEGF.
         2) Fusible link: 165 DEGF.
      b. Where non-standard applications exist, use higher rating.
         1) Use sprinklers rated at least 50 DEGF higher than anticipated ambient temperature.

D. Supports:
   1. Install in accordance with NFPA-13.

E. Testing - General:
   1. Test sprinkler and standpipe piping, including outside supplies, under hydrostatic pressure of 200 PSI for 2 hours.
      a. Prove system tight to satisfaction of Architect.
      b. Inside piping shall indicate no leakage.
      c. Leakage in underground piping shall be in accordance with NFPA-24.

F. Piping and Sprinkler - Application by room type:
   1. Areas subject to freezing:
      a. Sprinkler styles: Upright or dry pendant.
         1) Temperature rating: As required for room type.
      b. Provide sprinkler guards on pendant sprinklers.
   2. Electrical rooms/closets:
      a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
      b. Provide sprinkler guards.
   3. Elevator machine rooms:
      a. Provide shielding to protect electrical elevator equipment from sprinkler system discharge.
         1) Coordinate with elevator installer.
         2) Coordinate with authority(ies) having jurisdiction.
      b. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
         1) Fusible link temperature rating: 220 DEGF.
      c. Provide sprinkler guards.
   4. Finished rooms (rooms with ceilings):
      a. Sprinkler styles:
         1) Recessed pendant.
         2) Concealed pendant.
         3) Horizontal sidewall, standard or extended coverage.
      b. Where ceiling is being replaced in existing areas, relocate existing sprinklers to coordinate with new ceiling layout.
      c. Suspended ceilings:
         1) Install sprinklers so that escutcheons and ceiling plates do not cover ceiling grid.
      d. Locate sprinklers to coordinate with ceiling layout.
         1) Locate sprinklers centered in ceiling tile and in center of metal strip in linear metal ceilings, if such location makes added sprinklers necessary, provide added sprinklers as required to meet code.
   5. Mechanical equipment rooms:
      a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
         1) Glass bulb temperature rating: 200 DEGF.
         2) Fusible link temperature rating: 220 DEGF.
      b. Provide sprinkler guards.
   6. Substations:
      a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
         1) Fusible link temperature rating: 220 DEGF.
      b. Provide sprinkler guards.
   7. Telephone/Communication rooms/closets:
      a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
      b. Provide sprinkler guards.

8. Unfinished rooms (rooms without ceilings):
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).

3.3 ALARM AND SIGNAL DEVICES

A. Where multi-zone, wet-pipe fire protection sprinkler systems exist, provide waterflow detector at each zone take off immediately after isolation valve.

B. Install valve tamper switch on each isolation valve indicated below:
   1. Valves at bases of standpipes.
   2. Valves at fire system valves.
   3. Sprinkler-zone valves.

3.4 FIRE PROTECTION SYSTEMS

A. Factory trained Engineer shall supervise installation of fire protection systems.

B. On combination sprinkler and standpipe-and-hose systems, do not interconnect standpipes through sprinkler piping.

C. Factory trained Engineer shall provide following services:
   1. Supervise installation of fire protection systems.
   2. Instruct Owner's personnel in systems operations.

D. Test completed alarm systems including control and signal circuits wired by Electrical installer.
   1. Coordinate with electrical.
   2. Complete testing prior to substantial completion.

3.5 FIRE DEPARTMENT CONNECTIONS, FIRE DEPARTMENT VALVES, AND FIRE CABINETS

A. Install fire department connections, fire department valves, and fire cabinets at height required by authority having jurisdiction.
   1. Position valve to allow 12 IN spanner wrench clearance for connecting hoses.

B. Provide fire department connection location(s) as approved by the Campus Fire Marshall.

3.6 MANUAL VALVES

A. Provide isolation valves at following locations:
   1. Bases of standpipes.
   2. Fire system valves.
   3. On combination sprinkler and standpipe-and-hose systems, provide isolation valve at each sprinkler-zone take off from standpipes.

B. Provide check valves at following locations:
   1. Fire department connection.

C. Install indicator posts approximately 3 FT above grade.

D. Provide automatic ball drip at low points.
   1. Piping between outside fire department connection and check valve.

3.7 SYSTEM ACCESSORIES

A. Alarm Test Loops:
   1. Provide after each waterflow detector.
   2. Alarm test loop consists of two parallel branches.
      a. First branch: Inspector's test branch shall contain a shutoff valve and a restricting orifice imitating the flow through the smallest sprinkler on the system. Provide means

for inspector to observe water flow (e.g., drain water within sight of valve or provide sight glass).
b. Second branch: Drain branch shall contain shutoff valve.
c. Alarm test loop sizing criteria:
1) Riser or Main is 2 IN or smaller: 3/4 to 2 IN.
2) Riser or main is 2-1/2 to 3-1/2 IN: 1-1/4 to 2 IN.
3) Riser or main is 4 IN or larger: 2 IN.
3. Extend loops to nearest floor drain or mop sink.
a. Loops may be terminated outside when approved by authority having jurisdiction.
4. Label valves and outlets.

B. Drains:
1. Permit complete draining of systems without disconnection of piping.
2. Drain consists of dirt leg, valve, and piping.
3. Extend drain piping to nearest floor drain or mop sink.
4. Required locations:
a. At low points of systems.
b. At alarm test loops.
c. At fire system valves.
d. At bases of risers and standpipes.
1) 1-1/2 IN hose threads that match local fire department threads may be provided instead of extending piping.
5. Size drain valve and piping according to alarm test loop sizing criteria in this Section.
6. At offsets, plugs may be substituted for drains when approved by authority having jurisdiction.

C. Pressure Gauges:
1. Provide at following locations:
a. At service entrance to building.
b. At top of each standpipe.
c. At top of each sprinkler riser.
d. At alarm test loops.
2. Provide shutoff valve and drain for each gauge.

D. Sprinkler Cabinets.

3.8 ELECTRICAL WIRING

A. Provide Following:
1. Wiring diagrams for devices.
2. Supplemental fire detection systems and their wiring.
3. Wiring not specified but required to provide an operating system.

B. Electrical Installer shall provide following:
1. Alarm and signal device wiring:
a. Tamper switches: Supervised wiring to Fire Alarm System Control Panel.
b. Waterflow detectors: Supervised wiring to Fire Alarm System Control Panel.
c. Supervised wiring from waterflow detector to outside alarm bell.

END OF SECTION

SECTION 22 10 16
PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Plumbing Piping, as indicated, in accordance with provisions of Contract Documents.

B. Systems and Products Included:
   1. Systems:
      a. Cold, hot, and circulating domestic and industrial water piping systems within building and to 5 FT outside building wall.
      b. Drainage piping systems:
         1) Soil, waste, vent, and indirect piping within building and to 5 FT outside building wall.
         2) Acid resistant waste, and acid vent within building.
      c. Exposed piping in finished areas.
   2. Products:
      a. Backflow protection devices.
      b. Cleanouts.
      c. Drains:
         1) Air gap fittings.
         2) Downspout nozzles.
         3) Floor sinks.
         4) Roof drains.
      d. Traps.
      e. Valves:
         1) Automatic trap primer valves.
         2) Balancing valves, constant flow control.
         3) Check valves.
         4) Manual valves, potable water.
         5) Pressure reducing valves.
      f. Water hammer arresters.
      g. Water meters.

C. Definitions:
   1. Drainage piping: Soil, waste, vent, acid waste, acid vent, indirect, and storm piping.
   2. Brazing: High temperature soldering.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Outside Utilities: See Section 20 10 10.

B. Pipe and fittings standards: See Section 20 11 00.

C. Fire Protection Systems: See Section 21 10 00.

D. Valve standards: See Section 20 05 23 (for valves labeled "V-__").

E. American Water Works Association Standard AWWA C601: Sterilization Standard.

F. Plumbing and Drainage Institute Standard WH201: Water hammer arrester standard.

G. American Society for Sanitary Engineering Standard ASSE 1013: Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.

H. Standard: American Society for Sanitary Engineering Standard ASSE 1020: Pressure Vacuum Breaker Assembly.

I. Comply with NSF 61 for potable domestic water piping and components that come in contact with potable water.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Piping layout drawings at 1/4 IN/FT scale.

B. Product Data:
   1. Include sufficient information to verify compliance with specifications:
      a. Piping, fittings, and devices.
      b. Backflow protection devices.
      c. Drains.
      d. Valves.
      e. Water hammer arresters.
      f. Water meters.

C. Contract Closeout Information:
   1. Pressure test reports.
   2. Disinfection test report.
   3. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Reduced Pressure Principle Backflow Protection Device:
   1. Base:
      a. Wilkins Regulator
   2. Optional:
      a. Watts Regulator.
      b. Cla-Val.
      c. Hersey Measurement.
      d. Febco.

B. Vacuum Breakers Backflow Protection Devices:
   1. Base:
      a. Watts Regulator.
   2. Optional:
      a. Febco.
      b. Wilkins Regulator.

C. Cleanouts and Drains:
   1. Base:
      a. Wade Division/Tyler Pipe.
   2. Optional:
      a. Watts Drainage - Ancon.
      b. Josam Company.
      c. JONESPEC Plumbing Products.
      d. Jay R. Smith Manufacturing Co.
      e. Zurn Industries, Inc.

D. Automatic Trap Primer Valves:
   1. Base:
      a. Precision Plumbing Products.
   2. Optional:
      a. Jay R. Smith Manufacturing Co.
      b. Wade Division/Tyler Pipe.

E. Constant Flow Control Balancing Valves:
   1. Base:
      a. Griswold Controls COMBO.
   2. Optional:
      a. Flow Design Inc. - Autoflow.
      b. Preso.

F. Pressure Reducing Valves:
   1. Base:
      a. Cla-Val.
   2. Optional:
      a. Watts Regulator.
      b. Fisher.
      c. Wilkins Regulator.

G. Water Hammer Arresters:
   1. Base:
      a. Wade Division/Tyler Pipe.
   2. Optional:
      a. Jay R. Smith Manufacturing Co.
      b. Josam Company.
      c. Zurn Industries, Inc.

H. Water Meters:
   1. Base:
   2. Optional:
      a. Badger Meter.
      b. Hersey Measurement.
      c. Sensus Technologies.

I. Other manufacturers desiring approval comply with Section 01630.

2.2 PIPE AND FITTINGS

A. Domestic and Industrial Water Piping:
   1. 2 IN and smaller after service entrance:
      a. Above grade:
         1) Copper, Type L, with solder joints, and wrought copper or cast brass fittings.
            a) Solder must not contain more than 0.2 percent lead, and flux not more than a weighted average of 0.25 percent for wetted surfaces.
            b) Ring Seal Crimp fitting system: With approval of local authority having jurisdiction.
   2. 2-1/2 IN and larger after service entrance:
      a. Non-softened cold water:
         1) Copper, Type L, with soldered joints and wrought copper or cast brass fittings.
            a) Solder must not contain more than 0.2 percent lead, and flux not more than a weighted average of 0.25 percent for wetted surfaces.
      b. Hot water and soft water:
         1) Copper, Type L, with solder joints and wrought copper or cast brass fittings.
            a) Solder must not contain more than 0.2 percent lead, and flux not more than a weighted average of 0.25 percent for wetted surfaces.

3. Connections to existing galvanized piping:
   a. Threaded, mechanical cut groove, mechanical plain end, or flanged.

B. Drainage piping (soil, waste, vent, and indirect):
   1. Above grade:
      a. Cast iron, hubless pipe, fittings, and elastomeric sealing sleeves with stainless steel or cast iron clamps, as allowed by code.
   2. Below grade:
      a. 2 IN diameter or larger.
      b. Cast iron, hubbed pipe and fittings with elastomeric push joints, as allowed by code.

C. Drainage piping (Acid Waste):
   1. Below ground gravity DWV pipe and fittings shall be Non-Flame Retardant PolyPropylene, Schedule 40, Type 1 conforming to ASTM C4101.
      a. Fittings shall have an integral heavy gauge, nickel/chrome electrical resistance wire molded in place in the fitting body with no loose components. Connections between pipe and fittings below grade shall be fusion weld.
      b. Acceptable manufacturer: IPEX, "Enfield", or approved equal.
   2. Above ground gravity DWV pipe and fittings not located within spaces utilized as HVAC air plenums shall be Flame Retardant PolyPropylene, Schedule 40, Type 1 conforming to ASTM D4101. Material shall be flame retardant with maximum average flame spread of zero seconds and a maximum extent of burning of 13 mm, in accordance with ASTM D635. Matched fittings shall be manufactured from NSF listed flame retardant polypropylene with average maximum burn time of 80 seconds and maximum extent of burning of 20 mm in accordance with ASTM D635.
      a. Fittings shall have an integral heavy gauge, nickel/chrome electrical resistance wire molded in place in the fitting body with no loose components. Connections between pipe and fittings below grade shall be fusion weld.
      b. Acceptable manufacturer: IPEX, "Enfield", or approved equal.
   3. Above ground gravity DWV pipe and fittings located within spaces utilized as HVAC air plenums shall be Flame Retardant Polyvinylidene Fluoride (PVDF), Schedule 40, manufactured from Kynar 740-02, conforming to ASTM F 1673, with a limiting oxygen index (LOI) of 60, Resin must have a vertical burn rating of 94 V-0. Kynar 740-02 resin based on testing to ASTM E84 (UL 723) must have surface burning characteristics greater than or equal to a flame spread 5 and smoke development 35.
      a. Fittings shall be third party certified to ASTM F 1673 and ASTM E84, with a tapered elastic retaining ring designed to lock into a machined groove on the mating piping. All fittings shall have integrally molded union connections. No metallic grab rings or clamps shall be allowed.
      b. Acceptable manufacturer: IPEX, "Plenumline", or approved equal.
   4. Vent termination: All vent piping through the roof shall be High Silicon Cast Iron (HSCI), Duriron "Durichlor 50" or equal. Contractor shall adapt to metallic VTR below the roof - no plastic VTR's allowed.

D. Exposed piping in finished areas:
   1. Chrome or nickel plated brass to wall or floor.
   2. Piping 2 IN and larger may be provided with chrome or nickel plated brass sleeves to cover pipe and fittings.
      a. See Section 20 05 00.

E. Trap primer pipe between primer device and drain:
   1. Above grade: Copper, Type L, with solder joints, and wrought copper or cast brass fittings.
      a. Solder must not contain more than 0.2 percent lead, and flux not more than a weighted average of 0.25 percent for wetted surfaces.
   2. Below grade: Copper, Type K soft, with solder joints, and wrought copper or cast brass fittings.

2.3 BACKFLOW PROTECTION DEVICES

A. Backflow protection devices, general:
   1. Approved by local Public Utilities Bureau and the state Environmental Protection Agency.

B. Reduced Pressure Principle Backflow Preventer (BFP):
   1. Two check valves, test cocks, pressure differential relief valve, isolation valves and accessories assembled as an integral unit, horizontally mounted. Tested and certified in conformance with ASSE Standard No. 1013.
   2. Valve Monitoring: Integral relief monitor switch to automatically alarm in the event of catastrophic relief valve discharge.
      a. The relief valve monitor shall have an input voltage of 120 VAC, and shall be provided with outputs of 24 VAC and 120 VAC controlled by a user adjusted time delay relay.
      b. The relief valve monitor shall be housed in a water-tight NEMA enclosure, and shall have both normally open and normally closed outputs.
   3. Threaded ends: 2 IN and smaller.
   4. Flanged ends: 2-1/2 IN and larger.
   5. Provide 3/4 IN drain line from relief to floor drain, floor sink, mop sink, or service sink.
   6. Isolation valves:
      a. 2 IN and smaller: Ball valve.
      b. 2-1/2 IN and larger:
         1) OS&Y.
      c. Provide No. 1 test cock on inlet valve.
   7. Size BFP's to have a pressure loss less than 12 PSI at maximum flows indicated below (refer to plans for pipe sizes):
      a. 1/2 IN pipe: 2.2 GPM.
      b. 3/4 IN pipe: 6 GPM.
      c. 1 IN pipe: 13 GPM.
      d. 1-1/4 IN pipe: 22 GPM.
      e. 1-1/2 IN pipe: 35 GPM.
      f. 2 IN pipe: 75 GPM.
      g. 2-1/2 IN pipe: 125 GPM.
      h. 3 IN pipe: 170 GPM.
      i. 4 IN pipe: 315 GPM.

C. Atmospheric vacuum breakers (VB):
   1. Bronze body and lightweight internal float designed to eliminate spillage. Tested and certified in conformance with ASSE Standard No. 1001.
   2. Provide isolation valve immediately upstream of VB.
   3. Provide outlet connection on VB compatible with equipment/fixture being served.
   4. Mount bottom of VB at least 6 IN above the flood level rim of the equipment/fixture being served.
   5. Match VB size to pipe size indicated on plans.

2.4 CLEANOUTS

A. Cleanouts, general:
   1. Provide flashing collars and clamps for CO bodies being installed in floors with finishes installed over waterproofing.
      a. Coordinate with Division 09 and Room Finish installers.
   2. Dimensions are nominal.
   3. Body material (unless indicated otherwise): Coated cast iron.
   4. Cleanout plugs:
      a. Extra heavy, threaded, tapered, brass plug with solid hexagonal nut.
      b. Comply with Plumbing Code.
      c. Provide with American Standard pipe threads.

5. Cleanouts on lines completely accessible from within pipe chases do not require covers.
6. Cleanouts in exposed piping in equipment rooms do not require special covers.

B. Interior Floor Mounted Cleanouts:
1. Extra heavy, flanged, cast iron ferrule, tapped for cleanout plug with spigot or inside caulk outlet.

C. Example:
1. Two piece, threaded, adjustable housing.
   a. ANSI load class: Light duty, unless noted otherwise.
   b. Example: Wade 6000.
2. Top and cover as specified below by floor finish.
   a. Resilient tile and sheet finish: Round flange top with scoriated cover.
   b. Ceramic tile finish: Square flange top with scoriated cover.
   c. Poured finish: Round, wide flange top with scoriated cover.
   d. Carpet finish: Round top with standard top tapped for carpet marker bolt.
   e. Terrazzo finish: Round top with recessed for terrazzo cover.
   f. Quarry tile finish: Square, heavy duty top with heavy duty scoriated cover.
   g. Concrete finish in unfinished areas:
      1) Heavy, round frame; satin bronze, scoriated tractor top.
      2) ANSI load class: Heavy duty.
      3) Example: Wade 6000Z.

D. Cleanouts in vertical piping:
1. Tapped cleanout tee.
2. Extra heavy, threaded, brass plug with solid hexagonal nut.

E. Cleanouts in hubs of combination wye and eighth bends or wyes.
1. Tapped spigot.
2. Extra heavy, threaded, brass plug with solid hexagonal nut.

F. Cleanouts at ends of hubless combination wye and 1/8th bends or wyes.
1. Blind plug.

G. Covers over cleanouts in concealed vertical piping:
1. Square, nickel bronze frame with secured, smooth, stainless steel access cover.
2. 6 x 6 IN for pipe sizes 4 IN and less.
3. 9 x 9 for pipe sizes 5 IN and larger.
4. Example: Wade W-8480-S.

2.5 DRAINS

A. Drains - General:
1. Provide flashing clamps with seepage openings for drain bodies with flashing collars being installed in floors with finishes installed over waterproofing.
   a. Coordinate with Division 09 and Room Finish installers.
2. Provide underdeck clamps for drain bodies except those installed in slabs on grade.

B. Air Gap Fittings:
1. Inlet: Female IPS or collar with set screw.
2. Outlet: Spigot or IPS.
3. Material: Cast iron or bronze.
4. Minimum air gap area: 2 times inlet area.
5. Examples: Jay R. Smith 3950 series.

C. Downspout Nozzles:
1. DSN-1:
   a. Cast bronze nozzle with rough bronze finish and flange for securing nozzle to wall.
   b. Example: Jay R. Smith 1770.

D. Floor sinks:
   1. General:
      a. Dimensions are nominal.
      b. Provide trap primer taps where trap primer valves are required: See paragraph on trap primer valves.
      c. Material, unless indicated otherwise) Coated cast iron.
      d. Provide flashing collars.
   2. FS-1:
      a. 12 x 12 x 8 IN floor sink.
      b. Acid resistant enameled interior.
      c. Aluminum dome strainer.
      d. Full size, anti-tilt, 11 IN square, satin nickel bronze, removable grate.
      e. Example: Wade 9140.

E. Roof drains:
   1. General:
      a. Dimensions are nominal.
      b. Material (unless indicated otherwise): Coated cast iron.
      c. Provide deck clamps.
      d. Provide bearing pan/sump receiver where occuring at steel decks.
   2. RD-1:
      a. Flashing collar diameter: 16 to 19 IN.
      b. Flashing clamp with gravel stop.
      c. Mushroom dome: coated cast iron.
      d. Mushroom dome height: 5 IN.
      e. Mushroom dome diameter: 11 to 14 IN.
      f. Provide bearing pan/sump receiver.
      g. Provide solid or adjustable extension to allow for insulation thickness between concrete deck and waterproof membrane.
         1) Coordinate extension height with roof insulator.
      h. Example: Wade 3000.
   3. ERD-1 (overflow drain):
      a. Flashing collar diameter: 16 to 19 IN.
      b. Flashing clamp with integral 2 IN tall water dam.
      c. Mushroom dome and dam: coated cast iron.
      d. Mushroom dome height: 5 IN.
      e. Mushroom dome diameter: 11 to 14 IN.
      f. Provide bearing pan/sump receiver.
      g. Provide adjustable extension to allow for insulation thickness.
         1) Coordinate extension height with roof insulator.
      h. Example: Wade 3000D.

2.6 FLASHINGS

A. Lead flashings or thermoplastic elastomeric sheet membrane:
   1. Minimum 6 LB/SF, sheet.
   2. Provide for each pipe passing through roof:
      a. 18 IN square base with tubular vertical sleeve surrounding pipe with 1 IN minimum spacing, and turning in 2 IN at top.
      b. Provide gasket seal between vent top and lead sleeve.
   3. Provide for each floor and roof drain:
      a. 36 IN square.
      b. Clamp under drain's flashing clamp.

B. On floors above grade, allow for flashings provided by others at penetrations in floors with finishes installed over waterproofing.
   1. Coordinate with Division 09 and Room Finish installers.

2.7 TRAPS

A. Traps, general:
   1. Cast brass or cast iron, one piece pattern, 3 IN minimum seal.
   2. Same material, coating, and finish as piping system into which they are installed except traps 2 IN NPS and under, not buried in earth, shall be cast brass with union and cleanout.
   3. Place trap cleanouts in accessible locations.

B. Provide deep seal traps for drain bodies in ventilation housings: Traps need to maintain seal against static pressure in fan housing.

C. Traps for drains with buried outlet: Cast iron P-traps, unless otherwise indicated.

2.8 VALVES

A. Automatic trap primer valves.
   1. General:
      a. Rebuildable.
      b. Integral vacuum breaker on drain branch.
      c. Connections: Soldered or threaded.
      d. Provide trap primers as indicated on plans.
   2. Automatic trap primer valve:
      a. Serves single drain.
      b. 1/2 IN bronze.
      c. Designed to be installed in the supply line to an individual fixture with branch extended to drain.
      d. Examples: Wade 2400, Smith 2699.
   3. Automatic trap primer valve:
      a. Serves one to four drains.
      b. 1/2 IN brass.
      c. Integral backflow preventer.
      d. Designed to be installed at end of dead-end line with continuation to drain.
         1) Activated by 5 PSI drop or more in main.
      e. Automatically adjusts to line pressures between 35 and 75 PSIG.
      f. Example: Precision Plumbing Products Prime Rite.

B. Balancing valves, constant flow control:
   1. Factory calibrated, direct acting, automatic pressure compensating.
   2. Control flow rates within 5 percent of flow rating over operating pressure differential range.
      a. Set flow rating according to pipe sizes indicated on plans:
         1) 1/2 IN: 1.0 GPM.
         2) 3/4 IN: 2.5 GPM.
         3) 1 IN: 6 GPM.
         4) 1-1/4 IN: 9 GPM.
   3. Pressure differential range:
      a. 4-57 PSID.
   4. Threaded brass or copper sweat body with stainless steel internal parts.
   5. Provide a metal identification tag with chain for each installed valve.
      a. Identify zone or location, valve model number, flow rate, direction of flow, and differential pressure range.
   6. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.
   7. Provide manual valve upstream and downstream of each valve.

C. Check Valves:
   1. 2 IN and smaller: V-24 or V-25.
   2. 2-1/2 IN and larger: V-28 or V-29.

D. Manual Valves, Potable Water:
   1. 2 IN and less: V-13 or V-14.
   2. 2-1/2 to 4 IN:
      a. V-33 or V-35 or V-62.
   3. Balancing cocks:
      a. V-11.
      b. Constant flow control balancing valves.

E. Pressure Reducing Valves:
   1. Use pilot operated or direct acting PRV based on pipe size indicated on plans.
      a. 2 IN and smaller: direct acting.
      b. 3 IN and larger: pilot operated.
   2. Direct acting PRV.
      a. Bronze bodied, diaphragm and spring type valve with integral thermal bypass and removable, stainless steel strainer.
      b. Pressure adjustment range: 100 to 500 kPa 15 to 75 PSIG.
      c. Size PRV's to have a maximum fall off pressure of 15 PSIG at flows indicated below (refer to plans for pipe sizes):
         1) 1/2 IN pipe: 2.2 GPM.
         2) 3/4 IN pipe: 6 GPM.
         3) 1 IN pipe: 13 GPM.
         4) 1-1/4 IN pipe: 22 GPM.
         5) 1-1/2 IN pipe: 35 GPM.
         6) 2 IN pipe: 75 GPM.
   3. Pilot operated PRV.
      a. Hydraulically operated, pilot controlled diaphragm type valve.
         1) Pilot control: Direct acting, adjustable, spring loaded, normally open.
      b. Single removable seat and resilient disc.
      c. Fixed orifice in control system.
      d. Pressure rating: 150 class.
      e. Temperature rating: 180 degF.
      f. Valve body: Cast iron ASTM A48.
      g. Stainless-steel trim.
      h. Adjustment range: 100 to 500 kPa 15 to 75 PSI.
      i. Pipe size indicated on plans: 4 IN.
         1) Min PRV flow rate: 25 GPM.
         2) Normal maximum flow rate: 310 GPM.
         3) Maximum intermittent flow rate: 475 GPM.

2.9 WATER HAMMER ARRESTERS

A. Engineered, and certified in accordance with Plumbing and Drainage Institute (PDI) Standard WH-201.

B. Type and construction:
   1. Bellows type and constructed entirely of stainless steel.
   2. Piston type is not acceptable.

C. Water hammer arrestors shall be bellows type and constructed entirely of stainless steel.

2.10 WATER METERS

A. Domestic water meter shall be all bronze construction, positive displacement, single jet, or turbine type.

B. Use threaded fittings on meters 2 IN and less in size.

C. Use flanged connections on meters 2-1/2 IN and larger.

D. Provide valve on each side of meter. Provide strainer in line before meter.

E. Provide meters that can be remotely read by building's energy management system.
   1. The meter shall have DDC compatible pulse type attachment for remote reading and registering of both water; instantaneous flow rate in gallons per minutes; and consumption in gallons.
   2. Coordinate with Control Provider.

F. Public utility water meter:
   1. Provide full size bypass line around meter with a sealed valve.
   2. Provide capped tee immediately downstream of meter.

PART 3 - EXECUTION

3.1 GENERAL

A. General:
   1. Install piping as indicated and to provide fixtures and items of equipment with proper drainage, vent, and water connections as required by governing codes.
   2. Hold piping as close to structure as possible to maintain maximum head room.
   3. Run piping concealed wherever possible.
   4. Under no circumstances reduce pipe size indicated without written consent of Architect.
   5. Size branches to individual fixtures as scheduled.
   6. Consult the following before roughing in piping:
      a. Manufacturer's data.
      b. Large scale Architectural, and Mechanical Drawings of rooms containing equipment and plumbing fixtures.
   7. Stub piping through wall directly behind item being served (e.g., equipment, plumbing fixtures, vending machines).
      a. Cap and protect until such time as installation is performed.
      b. Exception: Upon approval of Architect, piping mains and/or branches may be run in lab benches, in built in counters, and in cabinet work.
   8. Plug or cap piping immediately after installation.
   9. Install chromed escutcheons on finished area sides of pipe penetrations.
      a. Secure escutcheons so they make contact with floor, wall, or ceiling.
   10. Install equipment in accordance with manufacturer's instructions.
   11. Connect equipment furnished by Owner or other divisions in accordance with Section 20 05 00.
   12. Install piping supports, sleeves, and seals as indicated in Section 20 05 29.

3.2 DOMESTIC WATER PIPING SYSTEMS

A. General:
   1. Install plumbing without cross or inter connections between potable and non-potable lines.
   2. Provide unvalved system drains on trapped portions of systems: See Section 20 05 19.
   3. Provide thermometers and pressure gauges where indicated on drawings: See Section 20 05 19.

B. Backflow Protection Devices.
   1. Provide at following locations:
      a. At fixtures and equipment as indicated and required by Code.
   2. Pipe drain from reduced pressure principle backflow preventers to drain or mop sink.

C. Balance Hot Water Circulation System.

D. Provide manual isolation valves at following locations.
   1. To isolate groups of fixtures and equipment on branch runouts from piping mains.
   2. On each branch serving a rest room.
   3. On inlet and outlet of each equipment.
   4. On each branch to hose bib or wall hydrant.
   5. At main feed points to domestic water pipe risers.
   6. As indicated and as required to adequately service parts of systems and equipment.

E. Wire isolation valves on emergency showers open and tag "Do Not Close".

F. Provide water hammer arresters on hot and cold water lines in accordance with PDI Standard WH-201 sizing and placement data; the Contractor shall be responsible for sizing of water hammer arrestors in accordance with this standard.

G. Testing of Water System:
   1. Upon completion of system or a section of system, test piping hydrostatically to pressure not less than 50 percent in excess of pipe's working pressure, but in no case less than 150 PSI.
      a. System shall hold pressure for 24 hours.
   2. Repair leaks or replace defective pipe disclosed by tests.
   3. Repeat tests until piping indicates tight.

H. Sterilization of Water System:
   1. Sterilize system as indicated or in accordance with AWWA C652 or CS186.
   2. Thoroughly flush water systems.
   3. After flushing, introduce chlorine or chlorine compound into system with dosage sufficient to give an initial residual chlorine content of 50 PPM.
   4. Collect samples from various taps and fixtures throughout buildings during introduction of chlorine to assure uniform distribution.
   5. Open and close valves several times.
   6. After a 24 HR contact period, flush traces of heavily chlorinated water from systems.
   7. After flushing is complete, indicate effectiveness of disinfection by submitting laboratory reports of bacteriological tests on samples taken from system.
   8. If unsatisfactory results are obtained, repeat disinfection process until satisfactory.
   9. Do not put system into service until tests are approved by Plumbing Inspector.

3.3 DRAINAGE PIPING SYSTEMS

A. General:
   1. Changes of direction and junctions: Make with wye fittings and eighth bends.
      a. Use sanitary tee fittings in vertical pipe only.
         1) Sanitary crosses not allowed.
   2. Provide P-trap for each direct waste pipe connection to equipment.
   3. Trap fixtures as required by governing code.
   4. Provide air gaps at indirect drains.

B. Slopes:
   1. Install horizontal soil, waste, and storm lines with following slopes:
      a. 3 IN and smaller pipes:
         1) 1/4 IN/FT.
      b. 4 IN and larger pipes:
         1) 1/8 IN/FT.
      c. Slopes indicated on plans override those indicated here.

C. Vents:
1. Run vent stacks parallel to soil and waste stacks to receive branch vents from fixtures.
   a. Each vent stack shall originate from a soil or waste stack at its base.
2. To permit proper flashing, offset through the roof piping away from walls on roof before passing through roof.
3. Carry vent stacks 4 IN and larger full size through roof.
4. Install vent lines so they will drain and not trap water.
5. Where possible combine soil, waste or vent stacks before passing through roof to minimize roof openings.
6. Extend vent stacks at least 12 IN above roofing.

D. Acid resistant waste and vent piping:
1. Install piping system free of stresses and in accordance with manufacturer's recommendations.
2. Provide accessories as indicated or required for complete connections.

E. Provide cleanouts on drainage piping as indicated below and on plans.
1. Locations:
   a. At each horizontal offset.
   b. At end of waste water or storm drains more than five feet in length.
   c. At base of vertical sanitary stacks.
   d. Above sanitary tees.
   e. In vent piping above urinals or at end of a battery of urinals.
   f. At dead ends.
   g. At changes of direction greater than 45 DEG.
   h. At junction of building drain and building sewer.
   i. 36 IN to 48 IN above finished floor in vertical piping that connects to horizontal soil, waste, or storm piping immediately below in ceiling space or under grade.
   j. As test tee to receive test plugs in each riser at least every other floor.
   k. At maximum 40 FT intervals in horizontal 4 IN and smaller drains.
2. Sizes:
   a. 4 IN diameter and smaller piping: Match pipe size.
   b. 5 IN diameter and larger piping: Not less than 4 IN.
3. Where cleanouts occur in concealed spaces, provide with extensions to wall or to floor above.
   a. Make extensions using long sweep ells or wye and eighth bends.
4. Where cleanouts are indicated in ceiling spaces above critical areas, extend cleanouts through floor above.

F. Install piping and drains to allow for flashings provided under Roofing System Section.
1. Coordinate with Roofing installer.

G. Area Drains, Floor Drains and Floor Sinks:
1. At locations with waterproofing: Set top of flashing collar 1/2 IN below level of waterproofing.
2. At locations without waterproofing: Place drain integrally with poured concrete. Set top of drain flush with finished floor.
3. Set over P-traps.

H. Testing of Drainage Piping Systems:
1. Do not insulate, conceal, or install furring around pipe until it has been tested to satisfaction of Owner and Plumbing Inspector.
   a. If inspection or test indicates defects, replace such defective work or material and repeat inspection and tests.
2. Test piping at completion of installation of each stack or section of piping.
   a. Fill system with water to highest point and check joints and fittings for leaks.
   b. Eliminate leaks before proceeding with work or concealing piping.

c. Minimum test height: 10 FT.
d. Make repairs to piping with new material.
e. Peening and chiseling of holes or screwed joints is not allowed.

3. Upon completion of the installation, immediately prior to building turn over, video inspect all drain lines to ensure they are free of debris.

END OF SECTION

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SECTION 22 11 23
PLUMBING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Plumbing Pumps, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
   1. Circulating pumps.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Pipe and fittings standards: See Section 20 11 00.

B. Manual-valve and check-valve standards: See Section 20 05 23 (for valves labeled "V-__").

C. Standards:
   1. UL 778: Motor Operated Water Pumps.

1.3 SUBMITTALS

A. Product Data:
   1. Circulating pumps.
      a. Include pump curves with point of operation indicated.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.
   2. Owner instruction reports.

1.4 WARRANTY

A. Eighteen (18) months from start up.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Circulating pumps:
   1. Base:
      a. Taco.
   2. Optional:
      a. Armstrong Pumps.
      b. Bell & Gossett, ITT.
      c. Grundfos.
      d. Thrush.
      e. Aurora.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Pumps - General:
   1. Motors: Section 20 05 00.
   2. Motor data: As scheduled.
   3. Pump capacities: As scheduled.
   4. Provide disconnects.

5. Provide starters for 3-phase motors.
6. Basins: As detailed.

B. Vibration Isolation:
1. Provide in accordance with Section 20 05 50.

2.3 CIRCULATING PUMPS

A. Circulating Pumps:
1. In-line centrifugal.
2. Pump casing and impeller: Stainless steel or bronze, lead-free, designed for domestic water circulating.
3. Fractional-horsepower pumps: Seal-less.
4. Control:
   a. Aquastat on/off control. Pipeline mounted, immersion insertion element, single type, field adjustable temperature setting (refer to plumbing details for settings), SPDT type switch, 120 volt single phase power requirement connected to the lead wires in the terminal box of the circulator, for domestic water use, manufactured by Honeywell or approved equal.
   b. Provide dry contact output(s) to the Owner's building management system for minimum of; 1) status.

PART 3 - EXECUTION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Furnish piping, isolation valves, check valves, and fittings per manufacturer recommendation.

C. Provide manual isolation valves at following locations:
1. On inlet and outlet of each circulating pump.
2. As indicated and as required to adequately service parts of systems and equipment.

D. Provide check valve at outlet of each pump.

E. Valve Requirements:
1. See Section 22 10 16.

END OF SECTION

SECTION 22 33 00
DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Domestic Water Heaters, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Factory testing: Subject tank and elements to hydrostatic test pressure, 150 PCT in excess of working pressure. Certify that components are free of leaks.

B. Manufacturing standard: ASME Pressure Vessel Code.

C. ASSE 1017: Temperature Actuated Mixing Valves for Hot Water Distribution Systems.

D. NSF standard: Comply with NSF 61: "Drinking Water System Components-Health Effects", for materials that will be in contact with potable water.

1.3 RELATED WORK

A. Refer to Division 25 Integrated Automation Division for instrumentation and controls requirements. See Section 25 50 00 and Section 25 51 00.

1.4 SUBMITTALS

A. Product Data:
   1. Water heaters.
   2. Thermal expansion compensators.

B. Contract Closeout Information:
   1. Owner instruction report.
   2. Operation and Maintenance Data.
   3. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Boiler-Water Heated Instantaneous Water Heater:
   1. Base:
      a. PVI Industries.
   2. Optional:
      a. Armstrong.
      b. Aerco.
      c. Cemline.
      d. Lochinvar.

B. Temperature/Pressure Relief Valves.
   1. Base:
      a. Watts.
   2. Optional:
      a. A W Cash.
      b. Wilkins.

C. Thermal Expansion Compensators.
   1. Base:
      a. Amtrol.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS - GENERAL

A. High temperature limits shall prevent delivery of water that is hotter than that selected for delivery from heater.

B. Unless indicated otherwise, water pressure drop through heater shall not exceed 10 PSI.

2.3 BOILER-WATER HEATED INSTANTANEOUS WATER HEATER

A. Boiler-Water Heated Instantaneous Water Heater:
   1. Factory assembled, packaged commercial water heater with heater section, controls, and other components as indicated.
   2. Completely factory assemble water heater so that installation involves only setting, leveling, anchoring, and connection of piping and electrical services.
   3. Designed for potable water service.
   4. Feed-forward control principle.
   5. Easy access to heat exchanger without moving heater from installed position.
   6. Factory fabricated steel supports.
   7. Provide manufacturer's standard enamel finish.

B. Heat Exchanger:
   1. Heat exchanger package shall contain ASME Section VIII – Division 1 brazed-plate heat exchanger with a “U” stamp designed for a maximum allowing working pressure of not less than 150 PSIG and a maximum allowable temperature of not less than 300 DEGF.
   2. The brazed-plate heat exchanger shall be of the double-wall type, and provide a true air gap between heat exchanger plates and a visible leak path to atmosphere. The heat exchanger shall be atmospherically vented with a leak detection path on all plates.
   3. The heat exchanger shall consist of 316 Stainless Steel plates with a copper brazing material (or approved equal) oriented in a counter-flow arrangement, promoting turbulent flow to maximize heat transfer efficiency and reduce sediment build-up/scale formation on the heat transfer surfaces. Plate-and-frame type heat exchangers are not acceptable.
   4. The heat exchanger shall have staggered / offset connection ports to avoid collision between the boiler water pipe / fittings and the domestic water pipe / fittings.

C. Water Piping and Fittings:
   1. Domestic water: All pipe, fittings and trim devices in contact with domestic water shall be stainless steel, copper, lead-free bronze or lead-free brass and comply with the NSF-61 requirements for pipe, pipe fittings & fixtures.
      a. Each completed heat exchanger package shall feature:
         1) Dielectric pipe fittings between the copper tubing and the heat exchanger connection ports.
         2) Couplings / unions with removable EPDM gaskets to connect the pipe to the heat exchanger connection ports. The gaskets shall be EPDM peroxide cured material for chlorine/chloramine resistance.
         3) Isolation valves on the domestic water supply & return connections.
         4) A wye-type strainer, with blowdown valve, on the incoming domestic water piping.
         5) Heat exchanger water-side access ports for clean-in-place capability.
   2. Boiler water: All pipe. fittings and trim devices in contact with boiler water shall be carbon steel, copper, ductile iron, cast iron, brass or bronze.
      a. Each completed heat exchanger package shall feature:

1) Couplings / unions with removable EPDM gaskets to connect the pipe to the heat exchanger connection ports. The gaskets shall be EPDM peroxide cured material for chlorine/chloramine resistance.
2) Isolation valves on the boiler water supply & return connections.
3) A wye-type strainer, with blowdown valve, on the incoming boiler-water piping.

D. Thermostatic Temperature Control Valve:
1. Materials:
   a. Brass, bronze, copper, stainless steel, ceramic.
   b. Thermostatic mixing valves may contain plastic parts.
2. Hot/cold color coding.
3. ASSE 1017 compliant.
4. Renewable thermostatic and pressure-balance elements.
5. Compensates for changes in both temperature and pressure.
6. Integral checks and service stops.
7. Temperature control with built-in shut off; opens from cold to hot.
   a. Supply temperature: 120 DEGF.
8. Adjustable, temperature-limit stops.

E. Controls:
1. The completed heat exchanger package shall feature a control panel configured for 110-120 VAC, single phase (w/ Neutral), 60 Hz.
2. The completed control panel shall feature a PID temperature controller capable of maintaining the desired domestic hot water supply temperature within ± 2 DEGF under constant load conditions, and within ± 4 DEGF under normal fluctuating load conditions, and adjustable leaving water temperature range of 110-180 DEGF.
3. At a minimum, the temperature controller and control panel shall display the following information:
   a. Domestic water supply temperature.
   b. Domestic water temperature setpoint.
   c. High temperature limit.
   d. Alarm condition.
4. The temperature controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor the following:
   a. Enable / Disable the heat exchanger package.
   b. Adjust the desired domestic hot water supply temperature setpoint.
   c. Monitor the operating status of the heat exchanger package.
   d. Monitor the alarm status of the heat exchanger package.
   e. Monitor the domestic hot water supply temperature.
5. The temperature control shall also be capable of interfacing with an optional protocol converter in order to provide the same remote functions through BACnet®, LONWORKS®, or MODBUS® protocols.
6. The completed heat exchanger package shall contain an automatic reset high temperature limit aquastat which will immediately de-energize the electronic control valve and illuminate a red HIGH TEMP light if the domestic hot water supply temperature exceeds the user-adjustable high temperature setpoint.
7. Water control valve:
   a. 2-way electronically actuated boiler-water modulating/shut-off valve shall be provided to control the flow of water through the heat exchanger in low demand periods. The valve shall have a tight shut-off with no more that 0.02% Cv leakage rate. The valve shall fail closed on loss of power.

F. Other Components:
1. Temperature/pressure relief valve.
2. Entering and leaving water temperature gauges on all connections.
3. Entering and leaving water pressure gauges on all connections.

4. Factory enclosure with manufacturer's standard finish.

2.4 TEMPERATURE/PRESSURE RELIEF VALVES

A. Temperature/Pressure Relief Valves.
1. AGA and ASME-approved, tight-shutoff, self-closing, bronze-bodied.
2. Threaded inlet and outlet.
3. Test lever.
4. Capacity: Same power as water heater. See schedule.
5. Relief setting: 210 DEGF/150 PSIG unless otherwise required by code.

2.5 THERMAL EXPANSION COMPENSATORS

A. Thermal Expansion Compensators.
1. Factory-packaged, air-charged, steel tank designed and constructed for potable water service according to ASME Code - Section VIII.
2. Polypropylene liner.
3. Flexible butyl diaphragm that separates air from system water.
4. Air pressure shall be readily field adjustable through standard air valve.
5. Initial water charging not required.
6. Minimum system working pressure: 150 PSIG.
7. Maximum allowed system working pressure: 10 PCT below pressure setting of water heater's temperature/pressure relief valve.
8. Water temperature range: As scheduled for associated water heater.

PART 3 - EXECUTION

3.1 GENERAL

A. Install units in accordance with manufacturer's instructions.

B. Install units to allow complete access for servicing including removal of heater sections.

C. Set thermostat so heater will deliver scheduled leaving water temperature.

3.2 THERMAL EXPANSION COMPENSATORS

A. Provide thermal expansion compensator for each water heater.
1. Install compensator on inlet side of heater.
2. Install so that no valve exists between compensator and water heater.

END OF SECTION

SECTION 22 42 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Plumbing Fixtures, as indicated, in accordance with provisions of Contract Documents.

B. Definitions:
1. Aerator: Device that mixes room air with faucet's water stream.
2. Ledge mounted faucet: Faucet with body mounted on top of faucet ledge and covered by faucet housing or single escutcheon.
3. Bottom-mounted faucet: Faucet with body mounted beneath faucet ledge; each penetration is covered by single escutcheon.
4. Semi-cast: Fittings, return bends, and nuts are cast brass. Waste arms and wall bends are tubular.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manual Valve Standards:
1. See Section 20 05 23, for valves labeled "V-__".

B. Design and Installation Standards:
1. NSF standard: Comply with NSF 61: “Drinking Water System Components-Health Effects”, for fixture materials that will be in contact with potable water.

C. Accessibility Manufacturing and Installation Standards:
1. Americans with Disabilities Act (Public Law 101-336).
2. ANSI-A117.1, current edition.
3. Local authorities.
4. State authorities.

1.3 SUBMITTALS

A. Product Data:
1. Assemble submittals by mark number. Include sufficient information to verify compliance with descriptions.
2. Where model numbers differ from descriptions, submit to meet description requirements:
a. Faucets.
b. Hose bibbs.
c. Sinks.
d. Wall hydrants.
e. Undersink protective covers.

B. Contract Closeout Information:
1. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Two Handled Faucets:
1. Base:
a. American Standard Plumbing.

2. Optional:
   a. Chicago Faucet.
   b. T&S Brass & Bronze Works.
   c. Delta Commercial.
   d. Crane Plumbing.
   e. Eljer Plumbingware.
   f. Kohler.

B. Stainless Steel Fixtures:
   1. Base:
      a. Elkay Manufacturing.
   2. Optional:
      a. Just Manufacturing.
      b. Southern Kitchens.

C. Fixture Carriers:
   1. Base:
      a. Wade.
   2. Optional:
      a. Watts/Ancon.
      b. Jonespec.
      c. Josam.
      d. J R Smith.
      e. Zurn Industries.

D. Flow Control Devices:
   1. Base:
      a. Same as installed faucet or shower head.
   2. Optional:
      a. American Standard Plumbing.
      b. Chicago Faucet
      c. Crane Plumbing.
      d. Coyne & Delany.
      e. Delta Commercial.
      f. Eljer Plumbingware.
      g. Hydrotek.
      h. Kohler.
      i. Omni.
      j. Sloan Valve.
      k. T&S Brass & Bronze Works.

E. Hose Bibbs:
   1. Base:
      a. T&S Brass & Bronze Works.
   2. Optional:
      a. Acorn Engineering.
      b. Delta Commercial.
      c. Crane Plumbing.
      d. Croker West.
      e. Chicago Faucet.
      f. Sloan Valve.
      g. Speakman.
      h. Woodford Manufacturing.

F. Trim:
   1. Base:
      a. McGuire Manufacturing.

2. Optional:
   a. American Standard Plumbing.
   b. Brass-Craft Manufacturing.
   c. Chicago Faucet.
   d. Crane Plumbing.
   e. Dearborn.
   f. Eljer Plumbingware.
   g. Elkay Manufacturing.
   h. Just Manufacturing.
   i. Kohler.
   j. T&S Brass & Bronze Works.

G. Wall and Yard Hydrants:
   1. Base:
      a. Wade.
   2. Optional:
      a. Watts-Ancon.
      b. Jonespec.
      c. Josam.
      d. J R Smith.
      e. Woodford Manufacturing.
      f. Zurn Industries.

H. Undersink Protective Covers:
   1. Base:
      a. Truebro.
   2. Optional:
      a. McGuire.

I. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Construct or equip fixtures with air gap or anti-siphon devices to prevent siphoning non-potable water into potable water supply system.

B. Piping exposed in finished areas including fittings and trim:
   1. See Section 22 10 16.

C. Dimensions:
   1. Dimensions are Nominal.
   2. Multiple dimensions:
      a. First dimension: Side-to-side.
      b. Second dimension: Front-to-back.
      c. Third dimension: Top-to-bottom.

D. Manufacture accessible fixture assemblies to meet requirements of accessibility standards.

E. Faucets - General:
   1. Following general conditions apply unless detailed otherwise in specific descriptions:
      a. Renewable cartridges with integral seats (or renewable seats and stems).
      b. Materials:
         1) Brass, bronze, copper, stainless steel, ceramic.
         2) Plastic components are not acceptable.
      c. Finish:
         1) Chrome.
      d. Gooseneck spouts:
         1) Discharge at least 5 IN above rim of fixture.

e. Comply with NSF 61 - "Drinking Water System Components – Health Effects" for fixture materials that will be in contact with potable water.

F. Flow Control Devices - General:
1. Provide flow control devices with indicated maximum flow rates on listed fixtures:
a. Sinks:
1) Handwash: 0.5 GPM.
2. Material: Brass.
3. Finish: Chrome.
4. Accomplish controlled flow without aeration of water stream. Aerators are not acceptable unless specifically identified in the faucet description.
5. Flow control devices shall be disinfectable.
6. Comply with NSF 61 - "Drinking Water System Components – Health Effects" for fixture materials that will be in contact with potable water.

G. Semi-cast P-traps and Continuous Wastes:
1. P-trap, semi-cast:
a. 1-1/4 or 1-1/2 IN NPS cast brass return bend with clean out.
b. 17 GA x 1-1/4 or 1-1/2 IN OD copper tube tailpiece.
c. Nuts: Cast brass.
2. Continuous waste, semi-cast:
a. 1-1/2 IN NPS cast brass tee.
b. 17 GA x 1-1/2 IN OD copper tube tailpieces.
c. Nuts: Cast brass.

H. Sink Fixtures - General:
1. Following general conditions apply unless detailed otherwise in specific descriptions:
a. Stainless steel:
1) Finish: Softsatin.
2) Type: 302 (18-8) or 304 (18-8).
3) Sound deadening that covers complete undersides of each bowl.
4) Thickness:
a) Sink depth less than or equal to 10 IN: 18 GA.
b. Provide integral faucet ledge with holes:
1) Coordinate hole quantities, locations, and centerings with the following:
a) Faucets and trim indicated in fixture descriptions.
2) Provide exact number of holes necessary.
a) Use of faucet hole covers is not acceptable.

2.3 FIXTURE CARRIERS

A. Fixture Carriers:
1. Application:
a. This paragraph describes carriers for wall hung valves and wall hung fixtures except water closets.
2. Carriers consist of uprights, floor anchors, and fixture supports:
a. Fixture-support types are concealed-arm, exposed-arm, hanger-plate, and clinical-service-sink.
b. Include associated hardware.
3. Materials:
a. Coated cast iron.
b. Steel.
4. Weight of construction: Institutional.
5. Uprights: Rectangular structural steel.
6. Floor anchors:
a. Non-adjustable cast-iron floor anchors bolted to uprights; or steel-plate floor anchors integrally welded to uprights.

b. 4-hole anchoring to floor.

7. Concealed-arm fixture supports:
   a. Header couplings:
      1) Vertically adjustable with horizontally adjustable cross tie.
      2) Integral pipe sleeves.
   b. Secure arms to pipe sleeves with threaded or set-screw connections.
   c. Hardware for vitreous china fixtures:
      1) Leveling screws for four corners of fixture.
      2) Non-slip devices to lock fixture into place on arms.
   d. For flat-slab fixtures requiring set out from wall, provide 2 IN chromed wall escutcheons.
8. Hanger-plate fixture supports:
   a. Bolted attachment to uprights.
   b. Drilled/slotted to match fixture.
   c. Hardware for attaching fixture.
   d. Provide in adequate size and quantity to anchor fixture at every anchoring point on the fixture.
9. Match lengths, mounting locations, and sizes to fixture requirements.

2.4 HOSE BIBBS

A. Hose Bibb – General:
   1. Following general conditions apply unless detailed otherwise in specific descriptions:
      a. Material: Brass.
      b. Finish: As indicated.

B. HB-1, Polished Brass Hose Bibb with Vacuum Breaker:
   1. Fixture:
      a. 1/2 IN IPS male inlet, adjustable / removeable wall flange, lever handle, 3/4 IN garden hose outlet.
         1) Model: T&S Brass B-0718.
   2. Vacuum breaker:
      a. Garden hose vacuum breaker, 3/4 IN female garden hose inlet & male outlet.
         1) Model: T&S Brass B-5550-10.

2.5 SINKS

A. See Article 2.2 MATERIALS – GENERAL

B. S-1, Small single bowl, wrist blades and gooseneck, accessible:
   1. Fixture:
      a. 22 x 19 x 5-1/2 IN, Wall hung, stainless steel, single-bowl, 1-1/2 IN outlet
         1) Elkay ELVWO2219CS3.
   2. Faucet:
      a. Bottom-mounted, 4 IN spread, two 4 IN wristblades, 5 IN reach fixed gooseneck.
         1) American Standard Plumbing Monterry 7500.175.
   3. Trim:
      a. Supply: Chrome, 3/8 IN OD, soft copper tube, loose key stops, escutcheons.
      b. Grid drain: Chrome plated brass for 1-1/2 IN outlet with 17 GA x 1-1/2 IN OD copper tube tailpiece.
      c. P-trap: Chrome, 1-1/2 IN semi-cast with cleanout, with 17 GA x 1-1/2 IN OD copper tube trap arm.

2.6 SPARE PARTS

A. Provide two of each type of renewable cartridge, stem, and seat.

2.7 WALL HYDRANTS

A. Wall hydrants, general (Following general conditions apply unless detailed otherwise in specific descriptions):
   1. Materials: Type M copper, bronze, cast brass.
   2. Finish of exposed parts: Satin nickel.
   3. Integral, self-draining vacuum breakers.
   4. Key operated volume control/stop.
   5. Automatic draining, non-freezing.
   6. Nylon seats.
   7. Renewable cartridges with integral seats (or renewable seats and stems).
   8. 3/4 IN inlet.
   9. 3/4 IN hose-thread outlet.

B. WH-1:
   1. Fixture:
      a. Single temperature, exposed face.
         1) Wade W-8600.

2.8 UNDERSINK PROTECTIVE COVERS

A. Undersink protective covers, vinyl:
   1. Material: Molded closed cell vinyl.
   2. Minimum thermal conductivity at mean temperature:
      a. $k \leq 1.17$, 75 DEGF.
   3. Attachment method: Reusable snap clips or seamless pre-wrapped.
   4. Service: Covers to cleanouts and valves to be removable without damage to clips.

B. Hose bib protective covers (faucet sock):
   1. Material: 3M Thinsulate covered in waterproof nylon or vinyl.
   2. Attachement method: Slip over faucet and secure with attached self-fastening Velcro strap.
   3. Size: Nominally 6 IN wide x 6 IN long.

PART 3 - EXECUTION

3.1 GENERAL

A. Install fixtures in first class manner with proper connections to water, drainage and vent systems.

B. Install fixtures at manufacturer's suggested height unless noted otherwise.

C. Install fixtures in accordance with manufacturers' instructions.

D. See that proper grounds are set to form a secure base and an absolutely rigid setting for each fixture.

E. Provide guards and boxing as may be required to protect fixtures against damage from operations of other trades.

F. Where pipes penetrate walls, floors, or ceilings, conceal penetrations with chrome escutcheons or stainless steel plates.

G. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal with silicone sealant: See Section 07 92 16.

I. Provide undersink protective covers on water supply and waste lines exposed beneath accessible fixtures.

3.2 FIXTURE CARRIER LEVELING

A. Level fixture carriers by shimming floor anchors with steel washers of varying thicknesses.

3.3 ACCESSIBLE FIXTURES

A. Install accessible fixture assemblies to meet requirements of accessibility installing standards

3.4 ADJUST AND CLEAN

A. Valves with adjustable temperature-limit stop: Adjust stop to deliver maximum 110 degF.

B. Remove dirt from fixtures, fittings and traps.

C. Secure escutcheons against wall.

END OF SECTION

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SECTION 22 61 13
LABORATORY AIR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Laboratory Air System, as indicated, in accordance with provisions of Contract Documents.

B. This Section includes the equipment requirements for the compressed Laboratory Air (LA) system:
   1. Air compressors.
   2. Air receivers.
   3. Air dryer/filter skids.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Laboratory air system components shall be furnished by a single supplier.

B. Laboratory air system components shall provide compressed air of Class 2.2.2 quality, in accordance with ISO 8573.

1.3 RELATED WORK

A. Refer to other Mechanical Specification Divisions for general and special mechanical requirements.
   1. Work of other Mechanical Specification Divisions:
      a. Welding and brazing requirements.
      b. Insulation.
      c. Plumbing systems.
      d. Pipe hangers and supports.
      e. Piping and equipment identification.
      f. Process piping systems.

B. Refer to Division 25 Integrated Automation Division for instrumentation and controls requirements. See Section 25 50 00 and Section 25 51 00.

1.4 SUBMITTALS

A. Product Data:
   1. Performance data.
   2. Physical dimensions and weight data.
   3. Vibration and acoustical data.
   4. Piping diagrams, and field connections.
   5. Electrical and controls wiring data, and field connections.

B. Contract Closeout Information:
   1. Warranty.
   2. Owner instruction report.
   3. Operation and Maintenance Data.
   4. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Air Compressors:
   1. Base:
      a. Kaeser.
   2. Optional:
      a. Ingersoll Rand.
      b. Atlas Copco.
      c. Kobelco.
      d. .

B. Air Receivers:
   1. Base:
   2. Optional:
      a. Hanson Tank.
      b. Silvan Industries.
      c. Manchester Tank.

C. Air Dryers and Filters:
   1. Base:
      a. Atlas Copco.
   2. Optional:
      a. Deltech.
      b. Sullair.
      c. Ingersoll Rand.
      d. Zeks.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 AIR COMPRESSOR

A. Positive-displacement, one-stage, air cooled, rotary screw air compressor.

B. Assembly Includes:
   1. Air compressor.
   2. Drive motor.
   3. Aftercooler.
   4. Lubrication system.
   5. Regulation and control system.
   6. Inlet air filter and silencer.
   7. Sound attenuation cabinet.
   8. Moisture separators with automatic drains.
   9. Pressure relief valves.
   10. Aftercooler check valve.
   11. Base frame.
   12. Internal wiring.
   13. Piping.

C. Noise shall be 80 dBA or less at 3 FT measurement from compressor unit.

D. Airend:
   1. Composed of a stainless steel male and a female rotor with asymmetrical profiles.
   2. The rotors are mounted on roller and ball bearings which support their radial loads and axial thrust.
   3. The compression is accomplished in a single stage.

E. Separate Lubrication System:
   1. Pre-lubricated bearings and timing gears.

2. Lubricate for 15 seconds before startup and continue to be lubricated for at least 20 seconds after shutdown.
3. Provide for accurate measurement of oil level while compressor is in operation.

F. Inlet Filter Silencer:
1. Dry type on compressors.
2. Design for 125 PCT of compressor's expected capacity in SCFM.

G. Antifriction Bearings:
1. AFBMA L10 life of 120,000 hours minimum.
2. Regreasable while running via installed grease fittings.
3. Factory greased with wide temperature range, rust-inhibiting grease.
4. Provide details concerning motor shaft to compressor connection, including shaft seals.
5. Shaft seal:
   a. Spring-loaded carbon ring cooled by oil during operation.
   b. Provide gravity fed oil reservoir to provide lubrication in the event of a power failure coast down.
   c. Provide access covers for each bearing chamber and oil reservoir.

H. Motors:
1. Basic requirements applicable to motors that are provided and installed under this Section are set forth in Section 20 05 00.
2. Totally enclosed with forced ventilation, protection IP 55 class F with temperature rise in class B.

I. Control System:
1. Integral to compressor package.
2. Provide manual and automatic operation and be equipped with a fused disconnect switch capable of being padlocked in the off position.
3. Controls electrical power shall be from the single point source for the entire package. Provide NEMA 12 UL listed enclosure, transformers, motor starters, motor overload and short circuit protection devices, pump hand-auto-off control switches and indicating lights and other devices required for system operation.
   a. Power and control power sections shall be appropriately separated.
   b. Provide an uninterruptible power supply (UPS) for all controls. A power interruption shall not result in the interruption of the controls.
4. Compressor local panel and control devices shall be skid mounted and factory wired.
5. Adjustable timer for loading delay to prevent excessive starts.
6. Automatic shutoff of compressor during periods of low demand and excessive idling to conserve energy.
7. Incorporate safety devices to shut down unit and require manual reset in event of:
   a. High oil temperature.
   b. Discharge air temperature.
   c. Motor overload.
   d. Low-oil pressure.
   e. High-bleedoff air pressure.
   f. Low-discharge pressure switch.
   g. High-high discharge pressure switch.
8. The compressor controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls.

J. Compressor Local Panel:
1. Include the following instruments:
   a. Discharge air pressure gauge.
   b. Oil pressure gauge.
   c. Intake filter differential pressure gauge.
   d. Discharge air temperature gauges and lights.

e. Low oil pressure light.
f. Hour Meter:
1) Running time.
2) Loaded time.
2. Auto-operation light.
3. Power on light.
4. Motor overload light.
5. Unload/normal toggle switch.
6. Reset/start push button.
7. Stop push button.
8. High-oil temperature light.
9. High bleedoff air pressure light.
10. Hand off auto switch, in auto accept a run contact from BMCS.
11. Use push to test indicating lights.

K. Factory wire components to motor starters and control panels.

L. Accessories:
1. Automatic drain traps:
a. Electric stainless steel zero air loss drain valve assembly.
b. Power to be provided by Vendor via prewired skid system.
c. Drain valve shall have dry-contact for fault alarming to the BMCS.
2. Pressure safety relief valves:
a. ASME coded for Section VIII air service.
b. Safety valves shall be capable of relieving the total rated capacity of compressor at set pressure of 150 PSIG.
3. Permanently attached stainless steel identification name plates shall be supplied with each equipment unit and components.

2.3 AIR RECEIVER

A. Provide steel air receivers as shown on Drawings.

B. Receivers:
1. Shall be suitable for a maximum working pressure at the top tangent line, of 10 PCT or 25 PSIG above the highest normal operating pressure, whichever is greater, and shall be furnished with ASME stamp and certification papers.
2. Internally lined with a combination epoxy and polyamide-type resin.
a. Plasite 7133 or approved equal.
b. Receiver exterior shall be sandblasted, primed and painted with machinery enamel.

C. Floor Mounted Receivers:
1. Steel support legs or skirt, designed for bottom of tank 12 IN above floor.
2. Size in accordance with applicable seismic zone.

D. Accessories:
1. Manway.
2. Flanged inlet and outlet nozzles.
3. NPT drain nozzle:
a. Include an automatic electronic stainless steel zero air loss condensate drain valve assembly (1/2 IN, 120V, 60 Hz) for each receiver. Drain valve shall have dry-contact for fault alarming to the BMCS.
4. NPT relief valve nozzle:
a. Include an ASME pressure relief valve on each receiver, capable of relieving the total system rated capacity at the set pressure of 150 PSIG.
5. NPT pressure gauge nozzle:
a. Include a pressure gauge, with isolation valve, with 0-150 PSIG range.

6. Lifting lugs.
7. EPDM nozzle gaskets.

E. Nameplates:
1. Supply receiver with a 316L stainless steel equipment identification label mounted on a raised flat surface permanently attached to receiver.

F. Spare Parts:
1. Provide one spare gasket for manways and nozzles.

2.4 AIR DRYER

A. Packaged System:
1. Skid mounted, complete with interconnecting tower piping, valve manifold, filter units, and control wiring.
2. The air dryer unit shall be packaged ready for an air inlet, air outlet, and single-point electrical power connection.
3. The dryer package shall include a particulate pre-filter, coalescing pre-filter, and particulate after-filter on the skid fully piped and valved.

B. Dual Tower, Heatless Regenerative Desiccant Dryers.
1. Maximum purge volume shall be 15 PCT for heatless dryer package of inlet airflow.

C. Air Dryers:
1. Mount with two chambers on common baseplate.
2. Include valves, controls, and wiring necessary for complete system operation.
3. Regeneration shall use dry outlet air.
4. Initiate regeneration by dewpoint of outlet air, with an in-bed capacitance type moisture sensor and control system.

D. Dryer Package:
1. Design for drying compressed air from a saturated condition at 100 DEGF and 100 PSIG to a design dew point of -40 DEGF.
2. Do not exceed design dew point of the distributed air.

E. Air Dryer Vessels:
1. ASME code stamped for 150 PSIG, designed in accordance with Section VIII, Division 1, and stamped by the code inspector.
2. Design in accordance with state and federal codes, including ANSI, NEMA, NEC, and ISA.

F. Dryer System:
1. Design with a maximum pressure drop of 5 PSI at rated flow, temperature, and pressure.

G. Exhaust Muffler:
1. During purge, regeneration, and dry gas sweep, the air noise shall not exceed 80 dBA at 3 FT measurement.

H. Dryer:
1. Separate desiccant fill and drain ports.
2. Locate such that dryer piping does not have to be disturbed for desiccant change.

I. Dryer Skid Mounted Air Filters:
1. Provide three valve bypass piping, such that any filter element can be safely serviced while dryer is in operation.

J. Unit shall include separate tower pressure gauges with isolation valves, separate ASME code-rated safety relief valves, separate tower temperature gauges, and stainless steel diffuser screens to protect the desiccant at the inlet and discharge of each tower.

K. Dryer Control Panel:
1. Integral to dryer package.

2. Automatically alternate towers for regeneration in such a manner as to provide an uninterrupted air supply without any downstream pressure fluctuations.
   a. The pressures in both desiccant chambers shall be equalized prior to changeover.
3. Controls electrical power shall be from the single point source for the entire package. Provide NEMA 12 UL listed enclosure, transformers, motor starters, motor overload and short circuit protection devices, pump hand-auto-off control switches and indicating lights and other devices required for system operation.
   a. Power and control power sections shall be appropriately separated.
   b. Provide an uninterruptible power supply (UPS) for all controls. A power interruption shall not result in the interruption of the controls.
   c. 120 VAC for heatless air dryer.
4. Changing of a tower from a drying mode to regeneration mode shall be accomplished with switching valves.
   a. Carbon steel bodies, stainless steel internals, and Teflon seats and seals.
   b. Rated for 500,000-cycle life.
5. Switching valves shall be controlled by a four-way solenoid valve which directs dry air to the air cylinder on the control valve.
6. Provide dryer with purge/ regeneration control system to minimize regeneration cycles and maintain outlet dew point at or below specified requirement.
7. Local dryer control panel:
   a. Include indication of following:
      1) Power on.
      2) Left chamber depressurizing.
      3) Right chamber depressuring.
      4) Left chamber heating.
      5) Right chamber heating.
      6) Left chamber repressurizing.
      7) Right chamber repressurizing.
      8) Inlet valve malfunction.
      9) Exhaust valve malfunction.
      10) Dryer inlet pressure.
      11) Dryer outlet pressure.
      12) Left chamber pressure.
      13) Right chamber pressure.
      14) Moisture indicator.
8. Indicating lights shall be push-to-test.
9. Fail safe valve control mode to assure continuous supply of compressed air.
10. Provide optional controls to allow Owner to reduce purge air volumes in low flow applications.
11. The dryer controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls.

2.5 AIR FILTERS

A. Pre-filter and Coalescing Pre-filter:
   1. Located upstream of air dryer.
   2. After filter:
      a. Mounted downstream of dryer to capture desiccant or other particulate before they pass downstream.

B. Particulate Pre-filter:
   1. 1.0 micron rating.

C. Coalescing Pre-filter:
   1. 5.0 micron rating, 5 ppm(w) oil carryover.

D. Particulate After-filter:
   1. High efficiency, 0.01 micron rating.

E. Filter Elements:
   1. Filter media compatible with mineral or synthetic oils.
   2. Provide double O-ring seals.
      a. Elastomeric.
      b. Seal filter element to filter housing.
   3. Support media inside and out.
   4. Coalescing element:
      a. Rigid perforated sleeve for structural strength and an outer drain layer to permit oil and water to drain to bottom of element and not re-enter into air stream.

F. Filter Housings:
   1. Aluminum construction, corrosion-resistant lining, side or bottom drain port to suit installation.
   2. Housing shall be made so elements can be replaced without removing housing from piping.
   3. Pressure rating: 300 PSIG.
   4. Provide with integral differential pressure indicator.

G. Accessories:
   1. Coalescing filters shall have electrical solenoid drain valve with adjustable timer for sequential operation.
   2. Provide two sets of each filter cartridges, one installed in each housing for start-up, and one spare shipped with units.

2.6 PIPING SYSTEM

A. Skid piping and valve requirements:
   1. See Section 22 67 19.

2.7 VIBRATION ISOLATION

A. Vibration Isolation:
   1. See Section 20 05 50.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install equipment as indicated on Drawings and in strict accordance with manufacturers written instructions.

B. Install equipment on vibration isolation bases where specified elsewhere in the construction documents.

END OF SECTION

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SECTION 22 62 13
PROCESS VACUUM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Process Vacuum Systems, as indicated, in accordance with provisions of Contract Documents.

B. This Section includes the equipment requirements for the Laboratory Vacuum (LV) system:
   1. Packaged vacuum skids.
   2. Knock-out pots.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Process vacuum system components shall be furnished by a single supplier.

1.3 RELATED WORK

A. Refer to other Mechanical Specification Divisions for general and special mechanical requirements.
   1. Work of other Mechanical Specification Divisions:
      a. Welding and brazing requirements.
      b. Insulation.
      c. Plumbing systems.
      d. Pipe hangers and supports.
      e. Piping and equipment identification.
      f. Process piping systems.

B. Refer to Division 25 Integrated Automation Division for instrumentation and controls requirements. See Section 25 50 00 and Section 25 51 00.

1.4 SUBMITTALS

A. Product Data:
   1. Performance data.
   2. Physical dimensions and weight data.
   3. Vibration and acoustical data.
   4. Piping diagrams, and field connections.
   5. Electrical and controls wiring data, and field connections.

B. Contract Closeout Information:
   1. Warranty.
   2. Owner instruction report.
   3. Operation and Maintenance Data.
   4. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Process Vacuum Skids – Rotary Vane:
   1. Base:
      a. BeaconMedaes.
   2. Optional:
      a. Altas Copco.

b. Busch.
c. Dekker.
d. Becker.

B. Knock-out Pots:
1. Base:
a. Busch.
2. Optional:
a. Wintek Corp.
b. Airtech.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 PACKAGED PROCESS VACUUM SYSTEM – ROTARY VANE

A. Furnish a packaged system consisting of vacuum pump, receiver, controls, and all necessary accessories factory assembled and piped, requiring only a single-point connection of electrical, and drain piping to begin operation.

B. Vacuum Pumps:
1. Rotary vane type, sealed oil lubricated, air cooled.
2. Rating: deliver scheduled capacity at site elevation above sea level.
3. Provide integral oil separation to remove at least 99.5 PCT of oil from the exhaust stream.
4. Mount pumps on vibration isolation supports.
5. Provide initial charge of lubricating oil.

C. Receivers:
1. Vertical, ASME code stamped and rated for full vacuum to 200 PSIG.
2. Provide vacuum gauge and transmitter on receiver.
3. Accessories:
a. Automatic drain traps:
1) Electronic stainless steel zero air loss drain valve assembly for vacuum.
2) Power to be provided by Vendor via prewired skid system.
3) Drain valve shall have dry-contact for fault alarming to the BMCS.

D. Controls:
1. Provide integral control system to start and stop lead vacuum pump to maintain system set point vacuum. Lag pump shall start if lead pump fails to maintain vacuum.
2. Lead pump shall be time alternated.
3. Controls electrical power shall be from the single point source for the entire package. Provide NEMA 4 enclosure, transformers, motor starters, motor overload and short circuit protection devices, pump hand-auto-off control switches and indicating lights and other devices required for system operation.
a. Power and control power sections shall be appropriately separated.
b. Provide an uninterruptible power supply (UPS) for all controls. A power interruption shall not result in the interruption of the controls.
4. Provide run time meter for each pump with panel-mounted display.
5. The vacuum controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls.

E. Factory wiring of components to motor starters and control panels is required and shall be in accordance with Electrical Specification Division requirements.

F. Permanently attached stainless steel identification name plates shall be supplied with each equipment unit and components.

2.3 KNOCK-OUT POTS

A. Designed with low pressure drop for vacuum service and to provide a high degree of protection for your vacuum pump.

B. Carbon steel housing, ASME certification and tested for vacuum service. Housing self-supporting with legs for free standing installation. Viton gaskets and 150# raised face flanged process connections.

C. The separation of entrained materials from the gas stream accomplished in three stages:
   1. Bulk liquid separated from the gas by initial tangential flow of the gas stream into the vessel.
   2. Stainless steel demister pad removes the mist/fog, and acts as a prefliter removing larger solid particulates.
   3. Polyproplylene particulate filter which removes solids down to 10 microns.

D. The filter and demister pad are easily accessible through a removable lid.

E. Accessories:
   1. NEMA 7 liquid level switches.
   2. Sight glasses and manual liquid drain valve.
      a. Include an automatic electric stainless steel zero air loss condensate drain valve assembly (1/2 IN, 120V, 60 Hz) for each pot. Drain valve shall have dry-contact for fault alarming to the BMCS.
   3. Permanently attached stainless steel identification name plates shall be supplied with each equipment unit and components.

2.4 PIPING SYSTEM

A. Skid piping and valve requirements:
   1. See Section 22 67 19.

2.5 VIBRATION ISOLATION

A. Vibration Isolation:
   1. See Section 20 05 50.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install equipment as indicated on Drawings and in strict accordance with manufacturers written instructions.

B. Install equipment on vibration isolation bases where specified elsewhere in construction documents.

END OF SECTION

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SECTION 22 67 00
HIGH PURITY WATER PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes requirements for procurement, fabrication, installation, and testing of High Purity Water Piping systems, as indicated, in accordance with provisions of Contract Documents.

B. Work included:
   1. High purity water piping, services and accessories. Rough piping and final connections to all equipment (other than process tools) whether furnished under this Section or not.
   2. Sleeves and supports; cutting, patching and framing of openings; and flashing of wall penetrations for work under this Section.

C. Description of systems:
   1. Systems:
      a. Reverse osmosis water
      b. Deionized water.

1.2 RELATED WORK

A. Refer to other Mechanical Specification Divisions for general and special mechanical requirements.

B. Work of other Mechanical Specification Divisions:
   1. General mechanical requirements.
   2. Pipe hangers and supports.
   3. Piping identification.
   4. Deionized water system.

1.3 SUBMITTALS

A. Shop drawings:
   1. High purity water piping layout in 1/4 IN scale.

B. Product Data:
   1. Piping and fittings.
   2. Valves, indicating materials of construction, testing, and quality assurance procedures.
   3. Accessories.
   4. Indicating devices.

C. Installation Procedures:
   1. Pipe joining, for each piping material.
   2. Water system cleaning and sterilization.

D. Contract closeout information:
   1. Test reports:
      a. Pressure tests.
      b. Sterilization tests.

1.4 QUALITY ASSURANCE

A. Piping standards: Section 20 11 00.

B. Cleaning and Packaging of Piping, Fittings and Valves: Provide piping, fitting, and valves with manufacturer's standard cleaning and packaging for semiconductor applications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All high purity water piping system components shall be bagged and sealed immediately after manufacture to maintain cleanliness, and boxed and stored indoors at the manufacturing facility until shipped from the factory.

PART 2 - PRODUCTS

2.1 GENERAL

A. Acceptable manufacturers:
   1. Pipe, fittings, and valves:
      a. Chlorinated Polyvinyl Chloride (CPVC)
         1) George Fischer Sloane, Inc.
         2) Nibco / Chemtrol.
         3) Hayward Industrial.
         4) Spears Manufacturing.
      b. Beta-Polypropylene (PP)
         1) George Fischer.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 PIPING, FITTINGS AND VALVES – REVERSE OSMOSIS WATER

A. Piping:
   1. Chlorinated Polyvinyl Chloride (CPVC), Schedule 80, plain ends per ASTM-F441 with CPVC Schedule 80 solvent welded socket type fittings per ASTM-F439. CPVC shall be Type IV, Grade 1 per ASTM D-1784.
   2. Piping shall be manufactured specifically for pure water use, and shall comply with UL 723 for water filled 2 IN diameter and below, and flame/smoke developed shall be 25/50 or less.
   3. Solvent cement per ASTM-F493 with primer as recommended by manufacturer.
   4. Joining Materials and Methods: Solvent welding, using solvent and methods per manufacturer's recommended procedures.

B. Fittings: Injection molded, socket weld, CPVC classification 12454-B per ASTM D-1784.

C. Gaskets: EPDM or Neoprene.

D. Valves:
   1. 2 IN and Smaller:
      a. Ball: True union style, CPVC body and ball, socket weld end connections, PTFE (Teflon®) seats, EPDM seals. Valve shall have minimum pressure rating of 232 PSI at 68 DEGF.
      b. Check: Ball check style, CPVC body and ball, EPDM seat and seals, socket weld end connections. Valve shall have minimum pressure rating of 150 PSI at 68 DEGF.
      c. Sample: 1/4 or 3/8 IN, CPVC body and ball, socket weld end connections, PTFE (Teflon®) seats, EPDM seals. Valve shall have minimum pressure rating of 150 PSI at 73 DEGF.

2.3 PIPING, FITTINGS, AND VALVES – DEIONIZED WATER

A. Piping:
   1. Beta-PolyPropylene (PP) pipe, valves and fittings shall be manufactured from a Group 1, Class 2, beta-nucleated homopolymer material meeting the requirements of ASTM D 4101.

2. Pipe shall be SDR 11 dimensions with a pressure rating of 150 PSI when measured at 68 DEGF.
3. Pipe internal surface finish shall be Ra ≤ 40µin.

B. Fittings: Fittings shall be made from the same material as the piping, butt fusion type suitable for radiant heat (IR) fusion joining, SDR 11.

C. Gaskets: EPDM or Neoprene.

D. Valves:
1. 2 IN and Smaller:
   a. Check: True union ball check style, polypropylene body and ball, FPM seals, fusion socket weld end connections. Valve shall have minimum pressure rating of 232 PSI at 68 DEGF.
   b. Diaphragm: True union style with fusion socket weld end connections, polypropylene body, PTFE (Teflon®) diaphragm, stainless steel bolts. Provide position indicator. Valve shall have minimum pressure rating of 150 PSI at 68 DEGF.
   c. Sample: 1/4 or 3/8 IN, polypropylene body and ball, fusion socket weld end connections, PTFE (Teflon®) seats, EPDM seals. Valve shall have minimum pressure rating of 150 PSI at 73 DEGF.
2. 2-1/2 IN and Larger:
   a. Butterfly: Polypropylene body and disc, lug style flanged end connections, EPDM seals. Valve shall have minimum pressure rating of 150 PSI at 73 DEGF. All butterfly valves shall be rated for 150 PSI dead-end service in both directions, and bi-directional.

2.4 PIPING ACCESSORIES

A. All inline piping accessories, devices and specialty items shall be constructed from materials suitable for use with the other system components, and the system it serves.

B. For piping specialties, refer to specification Section 20 05 19. Additional requirements shall be as noted below, and shall govern.
1. System drains for hydronic systems:
   a. Provide with all stainless steel construction, including wetted materials.

C. Flow control valve, adjustable:
1. Maintain a constant flow rate with inlet pressure between 15 and 120 PSI.
2. ANSI flanged connections, EPDM seals, stainless steel fasteners. Spring construction shall be 304 stainless steel with PCTFE coating.
3. All constant flow valves shall have a calibrated flow dial and position indicator.
4. Valve body shall be constructed of material suitable for use with the other system components and the system it serves.
5. Valve shall have a minimum pressure rating of 150 PSI at 70 DEGF.
6. Basis of design: Asahi/America.

D. Backpressure valve:
1. Maintain a constant inlet pressure between 5 and 100 PSI.
2. Inline type, adjustable non-wetted spring, wetted PTFE (Teflon®) diaphragm.
3. End connections and body material suitable for use with the other system components and the system it serves.
4. Valve shall have a minimum pressure rating of 120 PSI at 140 DEGF.
5. Basis of design: Plast-O-Matic RVDT.

E. Pressure relief valve:
1. Relief pressure setting infinitely adjustable from 5 to 125 PSI.
2. Angle type, adjustable non-wetted spring, PTFE (Teflon®) shaft, wetted EPDM seals.
3. End connections and body material suitable for use with the other system components and the system it serves.

4. Valve shall have a minimum pressure rating of 150 PSI at 70 DEGF.
5. Basis of design: Plast-O-Matic RVT.

F. Flexible pipe connectors (FPC) for pumps:
1. Rubber covered, unpigmented PTFE (Teflon®) smooth bore core, flare through design, flanged connections with Type 316 stainless steel flanges and PTFE encapsulated gaskets.
2. Basis of design: Crane Resistoflex.

2.5 INDICATING DEVICES

A. Pressure gauges:
1. Liquid filled, all stainless steel with 1/4 IN stem mount, range 0-100 PSI unless otherwise indicated on the drawings.
2. Provide stainless steel body, PTFE (Teflon®) diaphragm seals for gauges mounted in plastic piping.
3. Basis of design: Ashcroft "Duralife".

PART 3 - EXECUTION

3.1 INVENTORY CONTROL

A. Upon delivery to the site, store all piping, fittings, and valves in a clean, dry, well-maintained environment. Store material in the original shipping containers. Open containers only as components are used.

B. Fittings and valves shall be used immediately upon being individually unpacked from their heat-sealed packaging. No further attempt at cleaning shall be made.

C. Protect piping system components from contamination at all times. Replace any system component contaminated during fabrication and installation with a new, clean item. Do not attempt to re-clean contaminated components in the field unless authorized by the Owner's Representative.

3.2 TOOLS AND EQUIPMENT

A. Provide clean, dedicated tools for high purity piping system fabrication and installation, keep separate from other tools, and use exclusively for working on the high purity water piping systems.

B. Clean tools at the start of each shift with IPA/DI water solution, and dry with pure, filtered nitrogen.

3.3 PIPING INSTALLATION – GENERAL REQUIREMENTS

A. Install piping and fittings as indicated in Section 20 11 00. Locate valves and in-line piping specialties to be readily accessible for operation and maintenance.

B. Install piping system to prevent or minimize high points which may prevent complete system venting. Unless otherwise shown on the drawings, all piping shall be installed horizontal without any low point.

C. The installed piping shall not interfere with the operation or accessibility of doors and windows; shall not encroach on aisles, passageways, and equipment; and shall not interfere with the servicing or maintenance of equipment.

D. All piping shall be run parallel with the lines of the building unless otherwise noted on the drawings.

E. Install piping to provide every fixture and item of equipment requiring high purity water with suitable supply connection.

F. Consult manufacturer's data and large scale details of rooms containing plumbing fixtures on architectural drawings before roughing-in piping. Plug or cap piping immediately after installation.

G. Connect equipment furnished by other divisions in accordance with Section 20 05 00.
   1. For each water supply piping connection to equipment by others, provide a union and a valve. Provide a wheel handle stop valve at each sink water supply. Minimum line size 1/2 IN.
   2. Cap and protect until such time as installation is performed.
   3. Contractor may, upon approval of Architect, run piping mains and/or branches in lab benches, built in counters and cabinet work.

H. Install piping so that entire system can be recirculated back to equipment that produces high purity water.
   1. Maximum non-recirculated dead-end length: 6 pipe diameters, or Contractor to provide jumper piping.

3.4 VALVE INSTALLATION – GENERAL REQUIREMENTS

A. All valves shall be installed with their stems horizontal or above.

B. Provide sampling valves as indicted on the drawings.

C. System drains:
   1. At low points of piping systems, provide valved drains to allow complete drainage of each system.

3.5 FABRICATION

A. Pay strict attention to progress of assembly to ensure that system ends and components are not left exposed to the environment when work is not in progress.

B. Prior to joining long runs or subassemblies together in final location environment (e.g. when two separate pipe runs meet for final connection), the surrounding ambient environment must be under temperature control at 70 ± 5 DEGF. Prior to final connections, the HVAC system should be in operation for ambient temperature control. If HVAC is still under construction, final connections must be postponed until such, or contractor may submit for Owner's Representative approval, a definitive plan for ambient temperature control up to the time of normal HVAC operations.

C. Piping shall be set on hangers/racks to adjust to the ambient temperature environment prior to final field joining of long runs or subassemblies.

D. The pipe shall be cut accurately and square to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment.

E. Cutting or weakening of structural members to facilitate piping installation is not permitted.

F. Field cut pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers.

3.6 WORKMANSHIP – FUSION WELDING

A. The installing tradesman shall inspect all polypropylene materials prior to installation. Using a white light source, materials shall be inspected for OD and ID surface imperfections, i.e. pits, scratches, stains, residues and discoloration. Surface or sub-surface anomalies within 1/4 inch of the fusion ends and/or any deficiency which compromises the wall thickness or integrity of the material shall be rejected and removed from the job-site. Material anomalies discovered in the field by the installing contractor and/or Owner's Representative shall be recorded in a report generated by the installing contractor and transmitted to Owner's Representative.

B. Whenever field fabrication/installation of polypropylene piping is required in non-controlled/non-protected areas, the installing contractor is required to protect the area of the fusion joint from adverse weather conditions. The permitted material and equipment ambient temperature range for IR-Fusion joining is between 50 and 90 DEGF. Outside this range, suitable action shall be taken to ensure that these conditions are maintained. Materials shall be at surrounding ambient temperatures prior to IR-fusion welding.

C. Cleanrooms and areas of strong air currents are of particular concern during IR-Welding. Due to the non-contact heating method of the fusing system, any stray air current can interfere with the radiant heat transfer process. Therefore, air currents must be addressed by the installing contractor:
   1. Shield the IR welder to prevent any drafts from interfering with the IR heater plate.
   2. Place approved tape over the clamping halves to prevent air from entering the small gaps between the two halves.
   3. Close off holes in the IR end caps since the holes may allow enough air infiltration to interfere with the weld.
   4. Whenever possible, move the IR welder away from direct air currents prior to IR welding.
   5. All fittings and pipe ends must be covered prior to IR welding. Note: This applies to all ambient conditions.

D. For weld traceability the installing contractor shall provide a fusion log on each fused joint noting joint number, date, and operator's name. Logs shall be turned over to the Owner's Representative at the end of the project for project archiving.

E. A thermal transfer printed label shall be placed beside the actual joint on the pipe/fitting and/or valve. Labels shall be made of white polyester and acrylic adhesive type material. Labels shall be High Purity labels for cleanroom and standard quality for non-cleanroom applications. HP labels must resist against: high temp (280 DEGF), 95% humidity, IPA cleaning agents and UV-rays. The IR fusion machine must interface with a printer to create a unique number identifying the IR machine, date, joint number, process status, plus designation for operator and QA/QC signatures. This information shall be recorded on each label.

F. In addition to approved procedures and provisions stipulated in the Contractor's "Field Quality Assurance Program," the following procedures shall apply:
   1. Conduct qualification tests for the fusion equipment and the fusion operators prior to the start of system fabrication. Conduct tests with the fusion system manufacturer's representative present and subject to approval by the manufacturer and Owner's Representative.
   2. Submit a duplicate of the manufacturer's published operating instructions for the use of the radiant heat butt fusion equipment to the Owner's Representative for review and approval.
   3. A sample radiant heat butt-fusion joint shall be made up by each fitter for each pipe diameter to be used, for both vertical and horizontal weld orientations. Submit sample joints to the Owner's Representative for inspection prior to the start of the project. The Owner's Representative shall compare the joint quality with high-quality welds produced by manufacturer.
   4. The Owner's Representative reserves the right to suspend fusion operations via Construction Management for noncompliance with specified procedures or standards.
   5. The Owner's Representative reserves the right to request the removal of any system joints deemed substandard or otherwise unacceptable. The acceptable IR weld criteria shall be:
      a. Uniform double beads on pipe OD. The complete absence of one bead (half) or the other, no matter how slight is cause for rejection.
      b. Weld will have no offset or joint misalignment greater than 10 percent of pipe wall.
      c. No angular deviation, due to misalignment.
      d. No visible inclusions or voids within the parallel lines of the wall thickness.
      e. The mid-point of the double bead shall never be less than or compromise the wall thickness.

f. The pipe or fitting exteriors must show no evidence of slippage in the clamps or the fusion machine. This condition is not acceptable regardless of bead formation.

6. Random field samples will be checked by Owner's Representative for excessive and/or thin wall anomalies.
7. The installing/IR-Operator shall perform 100% inspections on all personally made fusion joints.
8. The Owner's Representative shall inspect and sign off 100% of all polypropylene IR-Fused joints.

G. Within the fusion area, the component and tube to be jointed shall have the same wall thickness with a maximum permissible wall displacement of 10%.

3.7 WORKMANSHIP – OTHER JOINTS

A. Fabricate joints in socket welded piping in strict accordance with the piping system manufacturer's written procedures and recommendations.

B. Do not locate or use flux plastic primer/cement compounds near the piping system work area.

C. Fitters and helpers involved with the fabrication and installation of the piping system shall wear non-soiled apparel and clean latex gloves at all times.

D. Threaded Connections: Use only at equipment connections. Make up with PTFE (Teflon®) tape using no more than two wraps, beginning at large end of threads, wrapping toward small end, leaving two end threads exposed. Sealant material other than 100% pure PTFE (Teflon®) tape will not be acceptable. Use Fluoroware 100% pure PFTE (Teflon®) tape or an approved equal.

E. Flanged Connections: Center gasket per manufacturer's installation instructions. Tighten bolts in accordance with manufacturer's procedures and to recommended torque settings for gasket used. Procedure shall be submitted to and approved by the Owner's Representative.

3.8 HANGERS AND SUPPORTS

A. Securely support piping with cushioning to prevent swaying and vibration, allowing the pipe to move when thermal expansion and contraction occurs.

B. Install supports in accordance with the manufacturers recommendations, or at no greater than the following intervals:

Maximum Support Spacing @ 70 DEGF – Feet

Nominal Pipe Size (in)	PVC
3/4 and smaller	5
1 and 1-1/4	5-1/2
1-1/2 and 2	6
2-1/2 and 3	7
4	7-1/2

Note: Spans shall be reduced 1 FT for each 5 DEGF rise in temperature.

C. Where pipe is installed outdoors or where temperature changes may occur, supports shall be fabricated and installed to allow for pipe movement due to thermal expansion, allowing supports to act as guides rather than attaching the pipe rigidly at each hanger.

D. Unless noted otherwise, thermal growth for plastic pipe is 1 IN per 10 DEGF temperature change per 100 FT. The contractor shall evaluate the system for the requirement for and location of expansion loops, anchor points, and pre-stressing of piping in conjunction with the manufacturers recommendation and the Owner's Representative. The installing contractor shall locate any takeoff valves and branch lines so that there is no interference when these lines move due to thermal expansion.

E. Install piping hangers and supports in strict accordance with manufacturer's recommendations.

3.9 PRESSURE AND LEAK TESTING

A. Water piping systems shall be hydrostatically pressure tested following completion.

B. Do not insulate or conceal pipe until it has been tested to satisfaction of Engineer.

C. Installing contractor shall visually inspect all piping systems for completeness and readiness prior to hydrostatic pressure testing.

D. All tests shall be witnessed by the Owner's Representative.

E. Pressure test procedure:
1. Test fluid shall be semiconductor grade deionized water filtered to 0.2 Micron absolute.
2. Fill the piping system with DI water, opening all valves and ports to purge system of air.
3. Test pressure: ***Equal to the piping system rating, but not less than 150 PSI***. Pressure test shall be considered "passed" if there is no loss of pressure after four (4) hours.
4. If leaks are discovered in the piping system, note locations on an as-installed drawing, release pressure, drain the affected system(s), and dry by purging with high purity filtered nitrogen. If possible to isolate by means of permanently-installed manual valves the affected section of piping, only that section needs to be drained.
5. Take special care when repairing leaks. Remove fragments and particulate matter produced during joint preparation. Repair leaks, resume test.
6. Following all repairs recharge piping system and maintain test pressure for a period of 4 hours with no decay.
7. Unless a constant recirculation can be achieved through the piping system or piping segment that is being pressure tested, open valves and ports, drain and blow dry the system using filtered nitrogen upon completion of the pressure test(s). At the completion of all pressure tests on the system the contractor shall proceed with the sterilization of the system.

3.10 STERILIZATION

A. Conduct sterilization process after water purification system and end use equipment are operational and the piping system has been pressure and leak tested. Do not install ion exchange service units, filter cartridges, RO membrane elements, and other chemically sensitive equipment until after sterilization is complete.

B. Sterilization shall be witnessed by the Owner's Representative. Contractor shall give the Owner's Representative at least a five (5) day notice that sterilization will be done.

C. Lock out automatic and manual electric circuits, and shut and tag out feed valves to the system. Remove or isolate all sensitive instrumentation.

D. Persons performing this operation must use proper PPE as outlined in the chemical's Material Safety Data Sheet (MSDS), and follow the Owner's specific PPE requirements.

E. Sterilization procedure:
1. Pump 500 ppm Paraoxyacetic acid into the system at the primary water storage tank and circulate through the entire system for 4 hours.
2. Open and close outlets and sample ports each hour for 2 minutes.
3. At the end of the 4-hour recirculated period contact the Owner's Representative to determine proper drain/disposal method. When draining the system, the disinfection solution may need to be diluted with domestic water.
4. Open valves, unlock electric currents, and flush with semiconductor grade deionized water filtered to 0.2 Micron absolute until the disinfection solution is below detection upon sampling.
5. Follow ASTM method F60-68 to determine the bacterial population. This analysis requires the use of a Millipore MHBG03700 bacteriological filter disk with incubation of 24 hours

using Pseudomonas specific isolation agar. Bacterial population of the outlet water shall not exceed that of the water entering the system.

6. Install ion exchange units, filters, and RO membranes, furnished by others.
7. Rinse or flush newly installed system components and system piping with semiconductor grade DI water filtered to 0.015 Micron absolute.
8. Continue rinsing until accepted by the Owner's Representative.

F. At the completion of the sterilization process, place the semiconductor grade deionized water on line with equipment in operation and with the distribution piping systems in recirculation mode.

END OF SECTION

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SECTION 22 67 19
PROCESS PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Process Piping Systems, as indicated, in accordance with provisions of Contract Documents.

B. Work Included:
1. Process piping, services and accessories.
2. Rough piping and final connections to all equipment, other than process tools, whether furnished under this Section or not.
3. Sleeves and supports; cutting, patching and framing of openings; and flashing of wall penetrations for work under this Section.

C. Systems and Accessories:
1. Laboratory Vacuum (LV)
2. Laboratory Air (LA)

D. Completely coordinate with work of other trades.

1.2 SUBMITTALS

A. Product Data:
1. For piping and valves, submit list of suppliers with make and model number for materials, and manufacturer's printed data and illustrations of manufactured items identifying each size furnished.
2. Submittals shall be approved by the Owner's representative before any purchase is made.

B. Contract Closeout Information:
1. Operation and Maintenance Data for items requiring operational instructions or periodic maintenance such as: air vents, constant flow control valves, pressure relief valves, water flow measurement devices, etc.

PART 2 - PRODUCTS

2.1 PIPE

A. Laboratory Vacuum, (LV) and Laboratory Air (LA):
1. Laboratory Air piping:
a. Pipe and fittings cleaned for oxygen service or equal, per CGA pamphlet G-4.1. Use tubing filled with nitrogen purge and pipe ends capped. The interior surface shall be uniform, bright, smooth finish with particulate matter of no more than 0.038 g/in2 (as called for in ASTM B280 specification).
2. 4 IN and Smaller: Type L hard-drawn copper tubing, plain ends certified to ASTM B280 ACR specifications with brazed solder-type wrought copper (castings not allowed) fittings per ANSI Standard B16.22. May use rack grade, degreased, schedule 10S, 304L or 316L stainless steel, per ASTM A269, when approved by Owner.
a. Copper Tubing Joining Materials: AWS – BcuP-5 Classification, "Silverflow-15" or approved equal.
b. Brazing Copper Pipe to Brass Flanges: Flux is acceptable only if written permission is given to the installer by Owner before each respective project. A condition of the approval is that each joint be bench brazed, and inspected (and approved) prior to

installation. Approved brazing procedures are described under Part 3 Execution in this Section. Approved flux products include Stay-Silv, Stay-Brite, and Stay-Clean.

2.2 VALVES

A. Laboratory Vacuum (LV) and Laboratory Air (LA):
   1. 2 IN and Smaller: Non-lubricated, bronze body, Teflon® seats and seal, stainless steel ball, two piece, full port ball valve with threaded ends and lockable handle. Apollo No. 77-100 or owner approved equal.
   2. 2-1/2 IN and Larger: Amri "Cosmia", Mueller Series 56, Grinnell Series 8000 or Keystone Series 222 butterfly valve. Ductile iron body, lug style drilled and tapped, EPDM seat with stainless disc and stem. All butterfly valves shall be rated for 150 PSI dead-end service in both directions, and bi-directional.

2.3 PIPING ACCESSORIES

A. Inline piping accessories, devices and specialty items shall be constructed from materials suitable for use with the other system components, and the system it serves.

B. For piping specialties, refer to Section 20 05 19.

2.4 INDICATING DEVICES

A. For piping specialties, refer to Section 20 05 19.
   1. Additional requirements shall be as noted below.
      a. Pressure gauges:
         1) Provide with all stainless steel construction, including wetted materials.

PART 3 - EXECUTION

3.1 PIPING

A. General:
   1. Where different pipe materials interconnect, provide appropriate manufactured adapters or flanged connections with using expanded PTFE, non-ink embossed "Gore-Tex" cut sheet gaskets; 1/8 IN thick. Teflon® gasket. Torque to manufacturer's specifications.
   2. Unless noted otherwise, locate all hand operated vertical valves which require daily or more frequent operation, at a height not more than 7 FT above floor.
   3. Stubs: Install valves where indicated on the drawings and elsewhere to facilitate pipe cleaning, venting, drainage, flushing or testing.
   4. Label all piping in accordance with Mechanical Specifications Divisions.

B. Copper: Cut copper piping with wheel cutter. Debur all cut ends and blow out chips with nitrogen.

3.2 VALVES

A. Pipe risers:
   1. Provide isolation valves at main feed points to risers.
   2. Provide isolation valves at branch take-offs from risers.

3.3 COPPER AND STAINLESS PIPE INSTALLATION

A. Materials and installation work shall conform to applicable codes and regulations. Work shall be done in a competent manner using the latest techniques of the trade.
   1. Thread Fitting / Connections:
      a. Only 100 percent pure PTFE Teflon tape is acceptable for all Process Piping Systems.

2. Copper:
   a. Installer is responsible to supply qualified brazers, equipment, and materials for scope of work.
   b. Brazing shall conform to the following:
      1) Copper lines shall be brazed using an oxygen-fuel flame.
      2) For all copper lines, all joints will be brazed with AWS – BcuP – 5 Classification; Silverflow – 15 or owner approved equal.
      3) During brazing all gas lines must be continuously purged with 0.1 micron absolute filtered nitrogen gas, which shall be allowed to escape into the atmosphere through a purge restrictor. Purge relief vent will be positioned above the plane of the pipe. Open ends will be closed and spool piece stored at ambient temperature until installed. Portable hand held oxygen monitors will be used on pipe sizes 2-1/2 IN and larger. Monitors are to read in parts per million (ppm) level, percentage monitors are not acceptable. Welding and brazing will be done at less than or equal to 50ppm oxygen concentrations. For sizes 2 IN and down, timed purging is acceptable.

Based upon 20 LIN FT		
Tube O.D Diameter	**Tube I.D. Flowrate**	**Purge Time**
0.250	15 CFH	2 Min.
0.375	15 CFH	2.5 Min.
0.500	20 CFH	3 Min.
0.750	20 CFH	3.5 Min.
1.00	20 CFH	4 Min.
1.50	20 CFH	6 Min.
2.00	20 CFH	8 Min.

Purge Restrictor Size	
Tube O.D. Diameter	**Orifice Size**
3/8 IN and smaller	1/8 IN
1/2 IN to 1-1/2 IN	1/4 IN
2 IN	3/8 IN
4 IN to 6 IN	1/2 IN
8 IN and larger	3/4 IN

      4) No brazed joint can be less than 12 IN away from the end of the purge line, which will require, in many instances, that an extension be used.
      5) Verification of all purge lines at the end of each shift. If project only has one shift, reduce purge to a trickle purge for overnight purging or capped under pressure. Inspect each flow meter for proper flow and verify that source of nitrogen will be sufficient until next shift startup.
      6) Maintain installation and purge procedures, for pipe runs, until installation is complete and accepted by the Owner.
      7) Joints which show evidence of overheating, cracking, poor penetration, or other defects of fit-up or workmanship, shall be replaced at installer's expense.
      8) If the system becomes contaminated due to fabrication techniques, prior to Owner's written acceptance, perform a total system re-clean or replacement. All expenses shall be borne by the installer, with no expense to the Owner.
      9) No more than 60 FT of pipe should be assembled in line prior to brazing.
      10) Pipes shall be cut with ends squared and true to size. Only clean tubing cutters with sharp cutting wheels shall be used. Hacksaws or similar type cutting tools shall not be used. All burrs must be removed.
      11) When cool, wire brush all fittings.

B. Material and workmanship shall be subject to inspection and examination by Owner.
   1. Copper:
      a. Upon request of the Owner, remove a random piece of installed work, sufficient to establish the quality of materials and workmanship. If the piece shows evidence of oxidation or contamination, the Owner may require testing of additional samples. If the additional samples are acceptable, the Owner will pay for the direct labor and materials required for the cutting out and restoration of these samples. If they are not acceptable, the cost shall be paid by the installer.

3.4 SYSTEMS PRESSURE TESTING

A. Test piping as noted below. Piping shall meet test conditions with no leaks or loss in pressure. Repair or replace defective piping until tests are accomplished successfully. Use of oil pumped air or nitrogen is expressly forbidden. Nitrogen used for testing and purging operations shall be from a cryogenic source. Re-testing following piping repairs shall be performed for full specified time period.

System	Test Pressure	Test Medium	Test Time
Laboratory Air	150 PSIG	Nitrogen	24 Hours
Laboratory Vacuum	10 PSIG	Nitrogen	12 Hours

B. Any leaks found in copper or plastic piping systems shall be repaired in the following manner:
   1. Brazed joint – Remove/replace fitting and re-braze new joints.

3.5 PURITY AND PARTICLE ANALYSIS FOR LABORATORY AIR

A. Cycle a volume of gas through the line to maximum pressure of not less than 30 PSI and discharge the line through a particle counter. Maximum flow rate for the gas discharge is 3 CFM. Line shall be cycled enough times to exchange the total gas volume five times.

B. Take particle measurements and establish a baseline of particle counts that is no more than 5 percent of the starting value. If baseline particle counts do not reach a 5 percent point, then the gas line must be examined for sources of contamination and repaired.

C. Equipment:
   1. PMS Low Pressure Gas Probe with interface.
   2. Two 1/4 turn valves.
   3. One pressure gauge.
   4. One flow meter, 0-4 CFM.
   5. One notebook computer.
   6. One mass flow controller.
   7. Control and processing software.
   8. Misc. hardware.

D. Procedure:
   1. Connect particle counter to gas line.
   2. Charge gas line and adjust flow to 3 CFM using downstream valve.
   3. Close the upstream valve and charge line to max pressure.
   4. Enable the particle counter.
   5. Open the upstream valve and discharge the line until pressure is stable at minimum.
   6. Close the valve and recharge the line to maximum pressure.
   7. Note the particle count and gas volume.
   8. Cycle system five times (or five gas exchanges).
   9. Calculate particle counts (total particles/total gas volume).

E. Test Results:
   1. The required test results are based on particle counts measured at specific particle size classes for the different pipe use categories. Also the percent of line clean up is measured for the five cycles.
   2. Nitrogen:
      a. 100 particles/ft^3 maximum at 0.2um size.
      b. 10 particles/ft^3 maximum at 0.5um size.
      c. Final particle count less than 5 percent of the first cycle particle count.

END OF SECTION

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SECTION 22 67 21
DEIONIZED WATER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Deionized Water System, as indicated, in accordance with provisions of Contract Documents.

B. Section includes equipment requirements for Reverse Osmosis Deionized (RODI) water system:
1. Water softeners.
2. Dechlorination filters.
3. Reverse osmosis (RO) systems.
4. RO water storage tanks.
5. Repressurization pumps.
6. Deinoized (DI) mixed beds.
7. Ultraviolet (UV) sterilizers.
8. Final filters.

C. RODI system Vendor shall be responsible for design, procurement, fabrication, and delivery of skid assemblies, equipment, valving, controls and loose shipped materials required for a complete, operating system.

D. Installation of equipment and interconnecting piping, wiring, and controls is responsibility of Mechanical and Electrical Contractors under supervision of RODI system Vendor.

E. Vendor shall provide assistance in system commissioning, as specified herein.

F. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Installer qualifications:
1. Company regularly engaged in supply and servicing high purity water systems, including providing engineering services.

B. RODI system components furnished by single supplier.

C. RODI system components shall provide water of Reagent Type II quality, in accordance with ASTM D1193.

1.3 RELATED WORK

A. Work by Others:
1. Vendor is responsible for fabrication, procurement, and delivery of components of RODI system except as specified herein.
2. Installation responsibilities by others shall include:
   a. Installation of vendor-furnished equipment.
   b. Furnish and installation of interconnecting piping and valves between vendor-furnished skids and/or vendor-furnished equipment, based on fabrication drawings provided by the vendor.
   c. Furnish and installation of power and control wiring to vendor furnished control panels and skid-mounted disconnects for feeds to skid-mounted equipment, based on wiring schematics provided by vendor.
   d. Wiring of Building Management and Control System (BMCS) inputs from vendor-furnished control panel or devices to BMCS system I/O cabinet.
   e. Furnish and installation of RODI water distribution piping.

f. Furnish and installation of off-site regenerate "Service Exchangers" under separate service contract.

B. Work of other Mechanical Specifications:
1. General and special mechanical requirements.
2. Plumbing systems.
3. Pipe hangers and supports.
4. Piping and equipment identification.
5. High purity water piping system.
6. Seismic restraint. See Section 20 05 48.

C. Refer to Division 26 Electrical specifications for electrical requirements:
1. Electrical work.
2. Variable frequency controllers.
3. Medium voltage cables.
4. Motor starters and motor control centers.

D. Refer to Division 25 Integrated Automation Division for instrumentation and controls requirements. See Section 25 50 00 and Section 25 51 00.

1.4 SUBMITTALS

A. Shop Drawings:
1. Process flow schematic of proposed system, showing equipment and accessories, major flow piping, sizes, flow rates, stream conditions, and field connections.
2. P&ID of proposed system, with equipment, accessories, piping, meters and gauges, instrumentation and control devices, and major control loops.
3. Equipment and component layout.
4. Drawings for interconnection of piping systems.

B. Product Data:
1. Performance data, including pump curves.
2. Physical dimensions and weight data.
3. Vibration and acoustical data.
4. Piping diagrams, and field connections.
5. Detailed list of utilities and estimated rates of peak and average consumption.
6. Electrical and controls wiring data, and field connections.
7. Detailed electrical power requirements, including in-rush current, recommended fuse size, locked rotor and full load amperes.
8. Wiring diagrams showing terminations for interconnecting power and control wiring between panels and skids, including wiring to field installed devices.
9. Panel layouts.
10. Annotated catalog cut sheets of proposed controls and instrumentation.
11. Project specific Sequence of Operations (SOO).
12. Seismic calculations.
13. Installation procedures.

C. Contract Closeout Information:
1. Operation and Maintenance Data.
2. Owner instruction report.
3. Warranty.
4. Test reports.
5. See Section 01 77 00.

1.5 DESIGN CRITERIA

A. Design to follow City of Riverside, CA make up water conditions, supplied from domestic water system. Vendor shall be responsible for verification of make up water characteristics.
1. Temperature (DEGF) 55 – 86 range, 75 typical

2. Pressure (PSIG), min 65
3. pH (pH units) 7.2 – 9.0 range, 7.6 typical
4. Hardness (mg/l as $CaCO_3$) 69 – 290 range, 208 typical
5. Silica (mg/l as $Si0_2$) 9 – 32 range, 14 typical
6. Chlorine (mg/l as Cl) 37 – 280 range, 164 typical
7. Alkalinity (mg/l as $CaCO_3$) 56 – 210 range, 130 152 typical
8. Conductivity (micro-siemens/cm) 801 – 1660 range, 1254 typical
9. Magnesium (mg/l as $Mg/CaCO_3$) 16 – 44 range, 10 typical
10. Total Dissolved Solids (mg/l) 180 – 780 range, 385 typical

B. System performance criteria (product RODI water quality) shall be as follows:

Component	Spec
RODI Water Makeup, min (gpm)	6.3
RODI Water Usage, max (gpm)	25
RODI Water Circulation Supply, max (gpm)	50
RODI Water Supply Pressure, min (psig)	55
Conductivity, max (micro-siemens/cm; 77 DEGF)	1.0
Resistivity, min (meg-ohm-cm; 77 DEGF)	1.0
pH	N/A
Total Silica (ug/L; ppb)	3.0
Total Organic Carbon, max (ppb)	50
Sodium, max (ppb)	5.0
Chloride, max (ppb)	5.0
Endotoxin Units (EU/ml)	0.25
Bacteria (CFU)	10/100 ml

C. Piping system velocities shall be limited to following:
1. Supply Main and Laterals 0.5 FPS MIN. (or Re in turbulent range), 8 FPS maximum.
2. Return Laterals and Main 0.1 FPS MIN, 8 FPS maximum.

D. RODI water storage tank capacity, size, and connections shall be as indicated on the drawings. The vertical tank shall have a top which is capable of withstanding an external uniformly distributed loading of 25 LBS/SF, or a concentrated weight of 250 LBS.

1.6 AVAILABLE FACILITY UTILITIES

A. Following utilities are available for the DI water system:
1. Laboratory instrument grade air:
   a. Pressure 80 PSIG
2. Electric Power:
   a. Feed Voltage 480 V, 3-phase, 4-wire
   b. Frequency 60 Hz
   c. Maximum fluctuation ± 5 PCT for connected loads

B. Vendor shall provide local UPS capacity for system controls and instrumentation.

1.7 REGULATORY REQUIREMENTS

A. Seismic design of equipment, piping, and conduit supports and restraints shall meet or exceed the latest edition of the Building Code for the project's jurisdiction.

B. Submit four sets of wet-stamped calculations by registered civil or structural engineer in state where the project is located.

1.8 FACTORY TESTING

A. Vendor shall perform factory testing of factory-assembled components and skid assemblies prior to shipment and furnish certification.

B. The piping subassemblies shall be hydraulically leak tested as specified herein.

C. Notify Owner minimum ten (10) working days in advance of all factory testing so that they may be present to observe the factory testing.

D. Vendor RO Water Tank Testing:
1. Test and inspect tank with written documentation of test results supplied to Owner.
2. Tests shall include, but are not limited to following:
   a. Hydrostatic test for 24 HRS duration at rated tank pressure.
   b. Compliance check of tank and accessory dimension per Drawings.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
1. Each skid or equipment item shall be suitably prepared for the shipment in a manner requiring minimum re-assembly prior to operation.
2. The Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions employed with respect to materials and application.
3. All flange faces shall be protected by securely fastened Schedule 80 PVC blind flanges and full-faced red colored NBR gaskets on all vessel nozzles and face piping flange faces to prevent damage and contamination during shipment.
4. Equipment and components shall be completely free of water prior to any shipment preparation.
5. Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit.
6. The following shall be shipped to prevent freezing and exposure to temperature extremes in excess of manufacturer's recommendations:
   a. RO membranes.
   b. Ion exchange resin.
7. All instruments and valves, including auxiliary systems, must be securely mounted and/or supported to eliminate damage during shipment, and storage.
8. Supports and rigging connections shall be provided to prevent damage during lifting or unloading.
9. Threaded connections shall be provided with a pipe plug of the same material as the connections. Plugs shall have a hex head. Only 100 PCT Teflon tape shall be used as thread sealant.
10. Opened ends of tubes and pipe shall be capped (taping alone is not adequate) for protection, and double wrapped to minimize contamination.
11. All equipment shall be packed, securely anchored (frame mounted when required) and weather protected. Separate, loose, or spare parts shall be boxed and each part individually protected as required. Each individual container shall be marked both inside and outside with the equipment number and service for which the parts are intended.
12. Each container shall also include a complete Bill of Materials identifying each part. In some instances, such as instruments, specific tagging shall be required.
13. Piping connections to skids or field-installed equipment shall be match marked to agree with Vendor's submitted connection table.

B. UV Sterilizer Cleaning and Packing:
1. After unit assembly and final manufacturers proof testing each UV sterilizer shall be wiped clean and dried using nitrogen gas prior to packaging for shipment.
2. After cleaning and nitrogen gas drying, completely assembled UV equipment shall have inlet and outlet connections capped with suitable blind flanges and red silicon gaskets, be double layer packaged in plastic and wood crated for shipment.

C. RO Skid:
1. RO skids shall be shipped to the job site complete with handling support and/or spreader bars to facilitate, if required, handling rigging and placement without damage to the RO skid, vessels, and/or piping.

2. Upon completing the factory testing, the vessel arrays shall be sanitized, drained, dried, nitrogen purged and sealed. The units shall be shipped fully assembled, without membranes, with the system components fully protected against vibration, freezing, bacterial attack, fouling, contamination and chemical deterioration.
3. The RO membranes are to be shipped in manufacturer's original containers, transported in temperature controlled trailers and may not be placed in direct sunlight at any time, and shall be maintained at temperatures >35 and <75 DEGF at all times. Storage, handling, installation and start-up procedures shall be provided and updated in accordance with manufacturer's recommended procedures and the project documentation requirements.
4. RO skid may be fabricated into separate mated support skids to facilitate shipment, rigging and installation. The Vendor's drawings shall clearly indicate skid connections.

D. RO Water Tank Shipment:
1. Prior to inspection and loading, all dirt and extraneous materials shall be removed from the tank interior. All exterior surface markings, special coatings, or contaminants shall be removed prior to shipment.

E. RO Water Tank Packing and Loading:
1. Flange faces shall be protected from damage by a closed-cell foam gasket and a securely fastened plywood covering.
2. Pipe, tubing, fittings, baskets, bolts, or any other small miscellaneous parts and accessories shall be padded and packaged in a crate or box and shipped with the tank.
3. Additional protection, such as battens, end wrapping, or other interior fastening may be necessary to ensure that the tanks are not damaged during shipment.
4. Exterior fittings, such as nozzles and tie-down lugs, will be padded and prevented from contacting other tanks and accessories in the same shipment.
5. Tank that is shipped on an open trailer shall be fully wrapped with plastic and completely covered with tarps to prevent contamination of the exterior and interior of the tank from road contamination and diesel soot/fumes.
6. The tank manufacturer will obtain a Certified Weight of the tank prior to delivery. This certified weight will be used by the riggers in determining the proper methods for rigging the tank during unloading and installation. Estimated weights or calculated weights will not be acceptable.

F. Equipment, including the RO Water tank, shall be inspected upon delivery at the project site prior to unloading, for damage. Any damage occurring during shipment shall be the responsibility of the Vendor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. RODI water system:
1. Base:
a. Evoqua Water Technologies.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. The RODI system shall consist of one completely new system, as specified herein and as indicated on the drawings.

B. System shall be designed and guaranteed by the Vendor to produce water to meet the requirements in this Section.

C. All components of the system shall be designed with maximum water quality, conservation and reuse in mind.

D. Equipment Packages:
   1. Mounting Skids: Each equipment skid shall include a structural steel base such that there is an even distribution of the equipment weight on the floor and, when fully loaded, there will be no distortion or unequal stresses upon equipment or face piping. Skid piping, valving, and instrumentation shall be completely supported from structural frame or vessel to prevent distortion from the vertical and horizontal planes. Upon arrival at the jobsite, skid piping shall be level with the vertical and horizontal planes over the skid length.
   2. The surface finish of the vessels, skids, pipe supports, and other ferrous metallic surfaces shall be primed with rust-inhibitive primer compatible with the paint, and painted with polyamide epoxy.
   3. Skid framing fabricated from I-beam or channel steel shall have anchor bolt holes drilled through both flanges of the structural member to allow anchor holes in the floor to be drilled vertically with the skid in place. Anchoring tabs shall be welded to skids with bases fabricated from hollow structural section. In all cases, there shall be a minimum of 18 IN vertical clearance above the anchor holes to allow for floor drilling. Where this is not possible, it shall be explicitly noted and reasons given.
   4. Pump bases and equipment skid frames shall be designed to allow the base or frame to be filled with grout after the equipment has been set.
   5. All equipment shall be mounted sufficiently high above skid frames to allow adequate clearance to all service points when the skid frames are filled with grout. When a spring-isolated inertia base is required, provide a base designed for concrete fill and spring isolation. Spring isolators shall be provided by the installation subcontractor. Concrete shall be provided by the installation subcontractor. Subcontractor to coordinate with installation subcontractor on spring clip design.
   6. Where applicable, a local control panels shall be provided installed on each skid. The panel rating shall be NEMA 4 minimum or equivalent. All instruments installed on the skid shall be wired to terminal blocks installed in the panel.

E. General:
   1. In no case shall sound levels exceed 85 dB measured 3 FT from the sound source as defined by SEMI S2-91 standards or equivalent. If equipment generates sound levels in excess of this, the vendor shall provide sound insulation to attenuate the sound to less than the specified level.
   2. Equipment and piping labeling shall be located in a manner such that it is easily visible and accessible to operators during normal operation of the equipment. Control components identification shall match the labels and identifiers shown on the P&IDs.
   3. Instrumentation and controls shall be mounted in a manner so as to be easily visible and accessible to the operators for use, calibration, maintenance, and replacement. The top of the highest instrument on local control panels shall be less than or equal to 6.5 FT above finished floor. The minimum height of local control mounted instruments shall be 42 IN above finished floor.
   4. Conduit, mechanical, and process piping shall be supported from epoxy-coated Unistrut or structural steel. FRP or PVC channel framing can be used for nonstandard applications. Galvanized metal and threaded rod are not allowed.
   5. For all motors, provide local locking disconnects.

F. Piping:
   1. Piping configurations shall not block maintenance access, and shall not block operator viewing of vessel sight glasses and instrumentation.
   2. Equipment and skid piping shall be designed and fittings shall be selected to minimize System “dead legs”. A dead leg is defined as minimum of four (4) pipe diameters of stagnant liquid which occurs when a valve is closed.
   3. Instrument air tubing on equipment and skids shall be flame-retardant polyethylene.
   4. Instrument and sample ports shall be located to avoid breakage by operators. Susceptible ports shall be protected by a mechanical plate or other external mechanical shield.

5. Resistivity, conductivity, and pH probes shall be installed in accordance with manufacturer's instructions and in such a manner to ensure the probes are continuously wetted when equipment is taken off line and drained.
6. Manual valve centerlines located more than 7 FT above the finished floor shall be equipped with chain wheel operators. Chains shall be sized such that the bottom of the chain hangs four to five feet above finished floor.
7. The hand wheel on gear operated manual valves shall be at least 6 IN in diameter.
8. The use of thread lubricants and sealants for the construction of the RODI system is prohibited at all times. Teflon tape that is impregnated with metals, or dyed with coloring is prohibited at all times. Only the use of pure, unpigmented (white), teflon tape on threads is acceptable.

G. Nameplates:
1. Attach a permanent stainless steel or self-adhesive chemically resistant plastic equipment identification label to each component. The label shall state the following minimum information:
   a. Equipment name and service.
   b. Equipment identification number.
   c. Name of manufacturer.
   d. Manufacturer serial number.
   e. Date of manufacture.
   f. Purchase order number.
   g. Nominal capacity.
   h. Design temperature and pressure.
2. The nameplate shall be clear coated to prevent chemical corrosion.

H. Extra Stock:
1. For each filter component, provide one full set of sacrificial filter cartridges for start up, and one full set of spare filter cartridges.

2.3 WATER SOFTENERS

A. Water softeners shall be Owner Furnished and Owner Installed.

B. Water softener ion exchange vessels shall be Service Exchanger type, with quick connect fittings on inlet and outlet to facilitate removal for off-site regeneration.

C. The Vendor shall provide header manifold to match the vessel count and configuration shown, and include all hoses and fittings for complete installation.

D. Ion exchange resins shall be high capacity sulfonated polystyrene type requiring no chemicals other than sodium chloride to obtain specified capacity. Or Vendor recommended as suitable for use in the intended softener application.

E. The Vendor shall provide the Owner with the service exchange requirements, and recommendations of local companies providing off-site ion regeneration vessel supply and service.

F. Equipment – vessels:
1. Each vessels volume shall be 3.6 cubic feet.
2. Vessels shall be filament wound FRP, rated at minimum 80 PSI working pressure.
3. Underbed construction shall be dished false bottom with electropolished 316L stainless steel slotted well screen strainer inserts and tailpipes.
4. Provide with earthquake resistant restraints.

G. Internal distributors and collectors:
1. The inlet distributor shall be of an electropolished 316L stainless steel high-flow header/splash-plate design.
2. An adjustable directional spray nozzle system, with header and laterals, shall be provided for sluicing the resin from the sides and the bottom of the tank. No more than 1/2 liter of

resin shall be left in the service vessel after each resin transfer. Nozzles shall have well screen inserts to prevent movement of resin back into the header during normal service when a constant purge will flow out of the vessel.

3. Well screen bayonet-style nozzles shall be provided for the bottom nitrogen inlet and the drain-down connections.
4. All internal hardware shall be electropolished 316L stainless steel.

H. Resin trap:
1. Resin trap shall have electropolished 316L stainless steel well screen with acrylic cylinder sandwiched between line flanges. Resin trap shall be in-line type with a resin flush port.

I. Acceptable manufacturers: Evoqua, or equal, three (3).

2.4 DECHLORINATION FILTERS

A. Dechlorination filters shall be Owner Furnished and Owner Installed.

B. Dechlorination filter ion exchange vessels shall be Service Exchanger type, with quick connect fittings on inlet and outlet to facilitate removal for off-site regeneration.

C. The Vendor shall provide header manifold to match the vessel count and configuration shown, and include all hoses and fittings for complete installation.

D. The dechlorination filters shall be granular activated carbon (GAC) required in the pretreatment/makeup water system for removal of residual chlorine and the reduction of nonpolar organics (TOC) from the city inlet water. Or Vendor recommended as suitable for use in the intended dechlorination application.

E. The Vendor shall provide the Owner with the service exchange requirements, and recommendations of local companies providing off-site ion regeneration vessel supply and service.

F. Equipment – vessels:
1. Each vessels volume shall be 3.6 cubic feet.
2. Vessels shall be filament wound FRP, rated at minimum 80 PSI working pressure.
3. Underbed construction shall be dished false bottom with electropolished 316L stainless steel slotted well screen strainer inserts and tailpipes.
4. Provide with earthquake resistant restraints.

G. Internal distributors and collectors:
1. The inlet distributor shall be of an electropolished 316L stainless steel high-flow header/splash-plate design.
2. An adjustable directional spray nozzle system, with header and laterals, shall be provided for sluicing the resin from the sides and the bottom of the tank. No more than 1/2 liter of resin shall be left in the service vessel after each resin transfer. Nozzles shall have well screen inserts to prevent movement of resin back into the header during normal service when a constant purge will flow out of the vessel.
3. Well screen bayonet-style nozzles shall be provided for the bottom nitrogen inlet and the drain-down connections.
4. All internal hardware shall be electropolished 316L stainless steel.

H. Resin trap:
1. Resin trap shall have electropolished 316L stainless steel well screen with acrylic cylinder sandwiched between line flanges. Resin trap shall be in-line type with a resin flush port.

I. Acceptable manufacturers: Evoqua, or equal, two (2).

2.5 REVERSE OSMOSIS (RO) SYSTEMS

A. Design Criteria: The reverse osmosis unit shall be designed to comply with the specified performance requirements. The Vendor shall recommend the hydraulic array most closely approximating optimum performance at the lowest applied system drive pressure.

B. The reverse osmosis unit shall be supplied complete with membrane elements (not installed), pressure vessels, interconnecting piping and valves, instrumentation and controls, sample taps, pressure gauges, pump control, control panel, and support structure.

C. Feed pumps:
1. Pump shall be an integral unit consisting of an ANSI B73.1 316 stainless steel vertical multistage centrifugal pump and motor.
2. Pump shall be non-contaminating and designed for the high purity service intended.
3. Single external mechanical seal model shall have silicon carbide/silicon carbide surfaces, and stainless steel metallic parts. Elastomers shall be viton.
4. All pumps shall be sized such that the impeller required at the given maximum flow and head is midrange of the impellers available in the casing provided. Motor horsepower shall be sized to prevent motor overloading at reduced system head.
5. Operating point shall not be to the right of the maximum efficiency on the pump curve.
6. Motor enclosures shall be TEFC. Motors shall be inverter duty rated, suitable for variable frequency drive operation, and 460 V, 60 Hz service.
7. No oils or grease shall be used during assembly of the volute and impeller.
8. Pumps shall be mounted on the top or side of the membrane skid, and shall be easily removable.
9. Basis of Design: ITT-Goulds SSV, 8.4 GPM, 3 HP.

D. Vessels/tubes:
1. The RO vessels shall be filament-wound FRP.
2. The vessels shall be designed, fabricated, and tested in accordance with ASME standards.
3. Vessel exterior finish shall be a white pigmented gel coat.

E. Membrane elements:
1. Membranes shall arrive on site in the original manufacturer's packaging. Performance test data on the membranes shall be available for any membrane required to be wet packed.
2. Furnish EPDM or Viton o-rings, gaskets, and seals. Furnish interconnectors and any other hardware required for a complete system.

F. Piping and valves:
1. All valving shall be within 6 feet of the finished floor. Isolation valves shall be provided across each pump and each vessel array.
2. CAM-LOC connections (Victaulic connections in high pressure piping) shall be provided across each vessel bank within an array for membrane cleaning.
3. Sample taps shall be provided on the product line from each vessel.

G. Controls: Solid state electronic controller.
1. Integral to reverse osmosis package.
2. Flow, temperature, resistivity, and pressure transmitters and indicators shall be supplied as required for a complete and operating system
3. Flow elements and indicators are required on the feed, product, recycle and reject streams. Includes percent recovery and rejection.
4. Temperature elements and indicators are required on the feed streams.
5. Resistivity elements and indicators are required on the feed and product streams.
6. Pressure transmitters and indicators are required on the pre-filter, pump discharge, product and reject streams.
7. Controls electrical power shall be from the single point source for the entire package. Provide NEMA 4 enclosure, transformers, motor starters, motor overload and short circuit

protection devices, pump hand-auto-off control switches and indicating lights and other devices required for system operation.
   a. Power and control power sections shall be appropriately separated.
   b. Provide an uninterruptible power supply (UPS) for all controls. A power interruption shall not result in the interruption of the controls.
8. Provide controls interface that is native controls compatible with the facility control system to enable the BMCS to remotely command and monitor all available and relevant control parameters. Refer to Section 25 50 00 and Section 25 51 00.

H. Provide with earthquake resistant structural legs with bolt downs.

I. Basis of Design: RO-RO-1 Evoqua, Vantage, model M41RS005, 6.3 GPM, one (1)

2.6 RO WATER STORAGE TANKS

A. A water storage tanks shall be provided to allow retention time for product water distribution.

B. Tanks shall be manufactured of linear, rotationally molded polyethylene with extra heavy wall construction.

C. Fabrication:
1. The tanks shall be vertical with cone bottoms and straight sides.
2. The tanks shall be provided with at least four lifting lugs evenly spaced and incorporated into the straight sides. Lifting lugs shall be of manufacturer's design, using 304 stainless steel material.
3. Cone-bottomed tanks shall be mounted on steel stand and basket assemblies with hold-down lugs. The hold-down lugs shall be made of 304 stainless steel.
4. Support stands and frames for conical bottom, horizontal and rectangular tanks must be reinforced to minimize bulging.
5. Support stands and frames shall be manufactured from carbon steel. Design shall be able to support the tank and tank contents having a specific gravity of 1.9. Design shall conform to the latest edition of the Building Code for seismic zone requirements.
6. Flanged nozzles, plate-gusseted nozzles, and bottom-drain nozzles shall be provided as required. All fittings shall be molded or seamlessly welded – gasketed bulk head fittings are not allowed. Flange diameters and drillings shall meet ANSI B16.4 150-pound standard. Compression molded, PVC long shank, double nut, high torque design flanges are acceptable. Nozzle bolt holes shall straddle natural tank center lines.
7. Manways shall be provided with all necessary gaskets, non-corrosive bolts, and covers.
8. Tank restraint system shall be supplied and the design for same certified by a structural engineer registered in the state where the project is located. Detailed instructions for installation shall be provided, along with all necessary hardware including anchor bolts. All components of the restraint system shall be stainless steel.
9. The final locations of nozzles and accessories shall be subject to change until shop drawing approval.

D. Accessories:
1. RODI water loop return spray ball fitting. Spray Systems 27500 or equal.
2. Hydrophobic PTFE submicron vent filter. Siemens FCVPTO6S1 or equal.
3. Non-intrusive level controls. Flowline Switch-Tek / Point or equal. 24 VDC power.
4. Tank repair kit containing all of the necessary components for small repairs.
5. Gaskets shall be Viton.
6. All flanges shall be covered with blind flanges and Viton gaskets bolted securely in place. However, the tank will be shipped in a manner that allows the tank to "breathe".

E. Finishes:
1. The tank support and basket assemblies shall be painted with corrosion-resistant epoxy paint.
2. The tank finish shall be natural polyethylene.

F. Provide with earthquake resistant structural legs with bolt downs.

G. Basis of Design: RO-TNK-1 Terracon, model CTS1040 (TPCC00750), 750 GAL, one (1).

2.7 REPRESSURIZATION PUMPS

A. Each pump shall be an integral unit consisting of an ANSI B73.1 316 stainless steel vertical multistage centrifugal pump and motor.

B. Pump shall be non-contaminating and designed for the high purity service intended.

C. Single external mechanical seal model shall have silicon carbide/silicon carbide surfaces, and stainless steel metallic parts. Elastomers shall be FPM (Viton).

D. All pumps shall be sized such that the impeller required at the given maximum flow and head is midrange of the impellers available in the casing provided. Motor horsepower shall be sized to prevent motor overloading at reduced system head.

E. Operating point shall not be to the right of the maximum efficiency on the pump curve.

F. Motor enclosures shall be TEFC. Motors shall be inverter duty rated, suitable for variable frequency drive operation, and 460 V, 60 Hz service.

G. No oils or grease shall be used during assembly of the volute and impeller.

H. Each pump shall be supplied with matched variable frequency drives (VFD), provided by the Vendor. VFDs will be in accordance with Specification Section 25 23 00.

I. Provide controls interface that is native controls compatible with the facility control system to enable the BMCS to remotely command and monitor all available and relevant control parameters. Refer to Section 25 50 00 and Section 25 51 00.

J. Basis of Design: DI-P-1&2 Grundfos, model CRN10-5, 50 GPM @ 80 PSI, 5 HP, two (2).

2.8 DEIONIZED (DI) MIXED BEDS

A. Deionized mixed beds shall be Owner Furnished and Owner Installed.

B. Mixed bed ion exchange vessels shall be Service Deionization (SDI) type, with quick connect fittings on inlet and outlet to facilitate removal for off-site regeneration.

C. The Vendor shall provide header manifold to match the vessel count and configuration (i.e. reverse-return) shown, and include quality light(s), and all hoses and fittings for complete installation.

D. Resin furnished shall be suitable for use in polish mixed bed deionizer application and for the intended application. The Vendor shall confirm with resin manufacturer the best vessel design to support the resin's unique characteristics.

E. The Vendor shall provide the Owner with the mixed bed ion exchange requirements, and recommendations of local SDI companies providing off-site ion regeneration vessel supply and service.

F. Equipment – vessels:
1. Each vessels volume shall be 3.6 cubic feet.
2. Vessels shall be filament wound FRP, rated at minimum 80 PSI working pressure.
3. Underbed construction shall be dished false bottom with electropolished 316L stainless steel slotted well screen strainer inserts and tailpipes.
4. Provide with earthquake resistant restraints.

G. Internal distributors and collectors:
1. The inlet distributor shall be of an electropolished 316L stainless steel high-flow header/splash-plate design.

2. An adjustable directional spray nozzle system, with header and laterals, shall be provided for sluicing the resin from the sides and the bottom of the tank. No more than 1/2 liter of resin shall be left in the service vessel after each resin transfer. Nozzles shall have well screen inserts to prevent movement of resin back into the header during normal service when a constant purge will flow out of the vessel.
3. Well screen bayonet-style nozzles shall be provided for the bottom nitrogen inlet and the drain-down connections.
4. All internal hardware shall be electropolished 316L stainless steel.

H. Resin trap:
1. Resin trap shall have electropolished 316L stainless steel well screen with acrylic cylinder sandwiched between line flanges. Resin trap shall be in-line type with a resin flush port.

I. Acceptable manufacturers: Evoqua, or equal, seven (7).

2.9 ULTRAVIOLET (UV) STERILIZERS

A. Design:
1. For bacteria destruction the ultraviolet light wavelength shall be 254 nm.
2. The UV dosage shall be at least 40,000 mws/cm^2 at 254 nm after 9,000 HRS of operation time.

B. General: As a minimum, ultraviolet sterilizers shall each have the following:
1. Single medium-pressure mercury vapor lamp in a quartz tube with electrical connections at both ends.
2. Single quartz sleeve to isolate the lamp tube from the product water.
3. UV monitor for continuous indication of UV lamp intensity.
4. High temperature switch for automatic lamp shutoff protection.
5. Clear labeling of each UV housing to indicate the lamp wavelength.
6. Clear labeling of each UV control panel to indicate unit service (e.g. Polish Loop Sterilizer), housing equipment number and electrical source.
7. An integral power-stepping function to maintain constant UV dosage during life of the UV lamp.
8. UV sterilizers shall be designed to allow the Owner to change the sterilizer purpose (operating wavelength) by changing out no more than the UV lamp and the quartz sleeve.
9. All wetted elastomers for the UV units shall be ozone-compatible. Solid Teflon gaskets shall not be used.
10. Provide with earthquake resistant structural legs with bolt downs.

C. Construction:
1. House high intensity ultraviolet lamps in recessed, specially fused quartz sleeves, with ozone-compatible (viton) seals, to isolate the lamp tube from the product water.
2. Wetted surfaces of the UV sterilizer chamber and other components shall be 316L stainless steel that is electropolished for a sanitary finish of less than 15 Ra microinches (36 Ra on welds). All stainless steel welds shall be full penetration and purged with inert gas, and weld radii shall be ground smooth prior to electropolish.
3. Quartz sleeves shall be watertight to allow lamp changeout without draining the chamber.
4. Inlet and outlet piping connections to the UV sterilizers shall be electropolished 316L stainless steel with a 50 Ra maximum surface roughness. As a minimum, stainless steel piping shall be used from the flanged UV sterilizer connection up to the flanged end of the inlet or outlet isolation valve.
5. A light trap, of at least one stainless steel 90 degree elbow and 2 FT of stainless steel pipe shall be provided at each connection.
6. Rate sterilizers at 150 PSI and test to 180 PSI.
7. Fabricate the ultraviolet chamber with a helical baffle for proper water passage through the unit for maximum germicidal and organic destruct efficiency, with a minimum 3X flow potential.
8. Electrical supply shall be single phase 120V, 60 HZ.

D. Power Panels:
   1. The sterilizer power panels shall be controlled and powered, and at a minimum, provide local indication of the following:
      a. Lamp ON/OFF status.
      b. Lamp intensity.
      c. Lamp run time.
      d. Alarm status lights.
      e. HAND/OFF/AUTO hand switches for lamp operation.
      f. Provide integral waterstop in conduit between the quartz sleeve and the power panel.
   2. The UV sterilizers shall be configured such that, if power to the UV sterilizer is interrupted or lost, the UV sterilizers automatically restart once the power source is regained.

E. Controls: Provide each sterilizer with a NEMA 4X stainless steel status display panel, optical sensor, intensity meter, lamp status indicator, temperature safety controls, and running time meter.
   1. Provide controls interface that is native controls compatible with the facility control system to enable the BMCS to remotely command and monitor all available and relevant control parameters. Refer to Section 25 50 00 and Section 25 51 00.

F. Basis of Design: DI-UV-1 Aquafine, model OptiVenn, 50 GPM, one (1).

2.10 FINAL FILTERS

A. Resin-Filter for makeup water filtration.
   1. Filter housing and element shall be constructed of polypropylene, with buna-n gaskets.
   2. Filter elements shall have a nominal removal rating at 5.0 microns absolute.
   3. Filter assembly (housing and element) shall be selected for a maximum pressure drop of 2 PSI at design flow rate. A differential pressure meter shall be provided with the housing cap.
   4. Filter housings shall be designed and constructed for 90 PSIG at 100 DEGF.
   5. Basis of Design: RO-FL-1 Pentek, Big Blue housing, DGD cartridge, 6.3 GPM, one (1).

B. High purity cartridge filter housings and elements for RODI water final filtration.
   1. Filter housings:
      a. Housing shall be designed and manufactured in accordance with ASME Code Section VIII, Division I.
      b. All filter housings shall be pressure tested in accordance with ASME pressure vessel code.
      c. Filter housings shall be of passivated 316L stainless steel construction. Elastomers shall be viton.
      d. Housings shall have a flanged side inlet and a flanged bottom outlet.
      e. The filter housing vent connection shall be a 1/4 IN FNPT fitting located at the top of the dome lid.
      f. All flanges shall be welded to the housing surface such that the flange face surface is parallel to the normal tangent at the point of connection within 1 degree (1/32 inch per 12 inches).
      g. The axis of any flange or connection shall be located with a bilateral tolerance of 1 degree around the perimeter of the housing relative to the axis of an opposing flange or connection.
      h. For vessel heads greater than 10 pounds, provide spring assisted or manual screw jack type of head lifting system.
      i. All filter housings shall be designed in a manner which minimizes the dead space above the cartridges (no domed top plates).
      j. The support rods and hold-down plate shall be designed to allow filter elements from multiple high-purity cartridge manufacturers.

2. Filter elements:
   a. Filter elements shall be high surface area filter cartridges, constructed of pleated glass microfiber media and polypropylene core, providing absolute particle retention and long on-stream life cycles.
   b. Materials of construction shall provide a wide chemical compatibility, with no leachables or extractables, for intended service.
   c. Pre-filters shall have a rating of 1.0 micron absolute. Post-filters shall have a rating of 0.2 micron absolute.
3. Basis of Design:
   a. Pre-Filter: DI-FL-1 Shelco; model 1UHF2V housing, 50 GPM, two (2); model HFC 20" cartridge, two (2).
   b. Post-Filter: DI-FL-2 Shelco; model 7UFS housing, 50 GPM, one (1); model MGF 30" cartridge, seven (7).

2.11 INSTRUMENTATION

A. The Vendor shall supply all control devices required for a complete and operating system, including (but not limited to) the following:
   1. Conductivity monitor:
      a. Transmitter:
         1) 4 line back-lit display.
         2) UL listed and CE compliant approvals, with NEMA 4X and IP 65 enclosure
         3) Power supply shall be 24 VDC, 5 W.
         4) Output shall be 4-20 mA.
         5) Ambient operating environment shall be 14 to 122 DEGF, 0-95 PCT relative humidity.
         6) Measurement shall be 0.02 to 2000 uS/cm, with an accuracy of +/- 0.5 PCT.
      b. Probe:
         1) 3/4 IN MNPT match probe, with patch cord as required.
      c. Basis of Design: Thornton, model M300 Dual Channel, one (1) unit, one (1) probe.
      d. Provide controls interface compatible with the facility control system. Provide output for connection of DI return water quality to the Owner control system.

2.12 VIBRATION ISOLATION

A. Vibration Isolation: Section 20 05 50.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. Vendor shall furnish onsite factory trained permanent employees as necessary to fully inspect the received equipment and supervise the entire installation of the RODI system (in accordance with all written Vendor instructions and specifications). Final acceptance of the RODI system shall be subject to satisfactory completion of the performance specifications detailed herein. Vendor's onsite employees shall supervise and document in real time any adjustments necessary and required for satisfactory operation.

B. Vendor's Responsibility and Services:
   1. The Vendor's employee(s) shall be prepared as necessary to assist the Mechanical and Electrical Contractors during installation and to provide written certification that the equipment has been installed as specified and in accordance with Vendor's requirements.
   2. The Vendor's employee(s) shall provide the initial start up of equipment in the presence of the Commissioning Authority and Owner.
      a. Provide a pre-start check of all piping, valves, control devices, control panels, and equipment.

b. Perform final calibrations and adjust equipment and controls for operation at the specified design conditions.
c. Provide a record of all start-up events noting problems and their resolution.
d. Provide a record of all set points for operational controls and devices.
e. Review the functional operating sequence associated with programmed PLC software and correct to comply with O&M manual documentation requirements and update the Vendor generated sequence of operations submitted before equipment shipment.

3. Upon the completion of equipment startup, provide up to 40 HRS of instructional time with the Owner's personnel to review the operations and maintenance manuals and perform each step necessary for start up, shut down, troubleshooting, and routine maintenance. The instructional times shall be scheduled through the Owner.
4. Upon completion of all inspection, start up, testing, check out, and validation procedures, the Vendor shall submit written notice to the Commissioning Authority and Owner that the RODI system is ready for use by the Owner.

3.2 EQUIPMENT

A. Vendor shall furnish equipment installation instructions in the form of drawings and written instruction as part of the Operation and Maintenance Manuals. Installation of factory-assembled equipment skids, loose equipment, interconnecting piping and accessories, control panels, interconnecting wiring, and instrumentation shall be by Mechanical and Electrical Contractors under Vendor's supervision.

B. Mechanical and Electrical Contractors shall be responsible for installation of equipment base pads for equipment skids, pumps, vessels, panels. Typical base pad details are provided on the Drawings.

3.3 TANK INSTALLATION

A. After inspection and acceptance by the Owner, the RO tank shall be unloaded, stored and subsequently installed by the installer. Tank shall be stored on a smooth, padded (as described for shipping) surface until installation. Care will be taken during storage to prevent flexing of the nozzles, brackets, or lugs and impacts and rolling.

B. The Mechanical Contractor shall verify field conditions prior to installation.

C. The Mechanical Contractor shall install the tank per the manufacturer's written instructions, this specification, and the drawings.

D. Prior to final placement of tanks, the Mechanical Contractor shall submit tank installation drawings to the Owner for approval of tank location, elevation, and orientation.

E. Prior to placing into service, interior surfaces including nozzle interiors and manway cover of the tank shall be wiped down with isopropanol using a lint free cloth and rinsed with deionized water. After rinsing and drying, openings shall be capped and sealed with clean rigid materials to prevent contamination of the tank.

3.4 FILTER INSTALLATION

A. Sacrificial and operational filter element sets shall be installed in the filter housings by the RODI water system Vendor.

B. Filter elements shall be shipped to the job site in the filter manufacturer's original, unopened shipping containers by the vendor just prior to installation in the filter housings.

3.5 INSTRUMENTATION AND CONTROLS INSTALLATION

A. Electrical Contractor shall install, connect, and calibrate field-mounted instrumentation and control devices in accordance with the drawings provided by the Vendor.

B. Panels and wiring shall be installed in accordance with applicable Sections in Electrical Divisions.

C. Vendor shall be responsible for installation, startup, debugging, and demonstration of PLC program software.

3.6 SYSTEMS PRESSURE TESTING

A. Test RODI system equipment and piping in accordance with applicable sections of this specification and Mechanical Specifications, when directed by the Owner.

END OF SECTION

SECTION 23 05 48
MECHANICAL SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Mechanical Seismic Restraint Systems, as indicated, in accordance with provisions of Contract Documents.

B. This specification covers design and installation of seismic bracing and anchorage required for piping, ductwork, and equipment. Contractor is responsible for design approval and installation of seismic bracing and anchorage systems.

C. Description of systems:
1. Transverse and longitudinal bracing for seismic forces on suspended mechanical systems including piping, ductwork, and equipment.
2. Anchorage of floor and roof mounted mechanical equipment.

D. Seismic bracing of vibration isolated equipment:
1. See Section 23 05 50.

E. Deferred approval items: Provide design and details of anchorages or restraints conforming to Title 24, Section T22-94215 Earthquake Regulations; prepared and signed by a Structural Engineer licensed in State of California.

F. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with Section 01 71 21, Specialty Engineering Requirements.

B. Seismic Design Requirements.
1. Seismic design criteria: Provide bracing and anchoring for equipment, piping, ductwork, stacks and breeching designed, constructed, and installed to resist stresses produced by lateral forces specified in section 01 41 40 Wind and Seismic Design Criteria.

C. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and suspended or wall mounted equipment weighing 20 LBS or more.

D. For this project, the following seismic coefficients shall be used in calculating the required lateral force:
1. Ip= 1.0, except as noted below:
   a. Ip= 1.5, for all life safety and critical systems including:
      1) Fire protection.
      2) Smoke Control.
      3) Fuel piping.
      4) Medical gas piping.
      5) Additional systems as defined by applicable codes.

E. All lateral forces shall be presumed to act through the components center of gravity.

1.3 INSTALLATION INSPECTION

A. Certify that seismic bracing system installed is in accordance with approved shop drawings

B. Certifier qualifications:
1. Pre-engineered systems: Qualified factory representative.
2. Custom engineered systems: Design engineer as identified under submittal requirements.

1.4 SUBMITTALS

A. Design Drawings:
   1. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
   2. Reference specific detail for each type of brace or anchor identifying required locations. Include plans and details.

B. Product Data:
   1. Technical data on seismic control devices.
   2. Certificate that seismic bracing system installed is in accordance with approved shop drawings

C. Project Information:
   1. Engineering calculations indicating design moments, shears, and other forces sealed by the Specialty Structural Engineer Submit concurrent with Shop Drawings.
   2. Deferred approval items: Provide design and details of anchorages or restraints conforming to Title 24, Section T22-94215 Earthquake Regulations; prepared and signed by a Structural Engineer licensed in State of California.
   3. Certificate that seismic bracing system installed is in accordance with approved shop drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Mechanical Seismic Restraint Systems:
   1. Base:
      a. Mason Industries.
      1) Amber/Booth Company.
      2) Vibro-Acoustics.
      3) Vibration Mountings and Controls.
   b. Other manufacturers desiring approval shall comply with Section 01 61 00.

B. Custom engineered systems designed using specified criteria and common building materials.

2.2 MATERIAL

A. Equipment Anchors and Supports:
   1. Drilled-in-place concrete anchors shall have an approved ICC Evaluation Services Report.
   2. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554-36.
   3. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.
   4. Structural steel for supports: ASTM A36.
   5. Cold formed metal and connection material: Unistrut or equal.

B. Details provided are based on assumed equipment and arrangement. Design and acquire approval for support and anchorage of equipment or arrangement which varies from detail provided.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Design and install bracing and anchoring for equipment, piping, ductwork, stacks and breeching in accordance with requirements of this specification.

B. A run is defined as suspended pipe, duct or trapeze rack having a minimum 5 FT straight run length.

C. Every run which requires bracing shall have a minimum of two Transverse Braces and one Longitudinal Brace.

D. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

E. Bracing may be omitted from piping, ductwork, conduit, cable tray and bus duct runs less than 5 FT in length.

F. Except for sprinkler piping, bracing may be omitted from piping and ductwork runs where rod hung supports of less than 12 IN in length are required, subject to the following:
   1. Unbraced suspended ductwork and other unbraced suspended utility systems are to be installed with a minimum 6 IN clearance to suspended ceiling vertical hanger wires.
   2. Install piping or ductwork such that lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.
   3. Supports are less than 12 IN for total run. Rod hung supports less than12 IN shall not create moment forces on the hanger rod.

G. A longitudinal brace at a 90 degree change in direction may act as a transverse brace if it is located within 2 FT or two duct widths, which ever is greater, of the change in direction.

H. A Transverse brace may act as a longitudinal brace if it is located within 2 FT or 2 duct widths, whichever is greater, of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

I. When bracing equipment or a utility system suspended from an overhead deck, brace back to overhead deck or structure supporting the deck.

J. Do not brace to another element of the structure which may respond differently during a seismic event.

K. Obtain approval from Structural Engineer prior to attaching to any brace elements to structural steel or wood framing.

L. Tension cable to remove slack from cable bracing without inducing uplift of suspended element.
   1. Tension seismic bracing system prior to equipment start up and adjust after start up.

M. Do not mix rigid bracing with cable bracing in same run unless approved by Structural Engineer.

N. Install brace members at an angle of 45 DEG from horizontal within a tolerance of plus 2 1/2 DEG or minus 45 DEG provided the brace length is accounted for in design. Brace angle may be increased to 60 DEG provided the brace spacing is reduced to 1/2 that required for a 45 DEG brace.

O. Seismic bracing may not pass through a building separation joint. Utility systems that pass through a separation joint must be seismically restrained within 5 FT of point of connection or any hardware designed to accommodate seismic movement across the span of the separation joint.

P. With approval of the Structural Engineer, utility systems within a basement that are suspended from the overhead deck may be braced to load bearing basement walls provided that the walls and the overhead decks will respond similarly during a seismic event.

Q. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

R. Pipes or ductwork constructed of non ductile material (plastic, fiberglass, or no hub cast iron), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials. In addition, no hub cast iron piping shall be braced on either side of a horizontal 90 degree change in direction and when installed as a riser, shall include the use of a joint stabilizer where the joints are unsupported between floors.

S. Where brace elements are through-bolted, mounting hole in element is to be no more than 1/16 IN diameter larger than bolt or threaded rod.

T. Seismic braces shall directly brace system and not hanger.

3.2 SUSPENDED PLUMBING, MECHANICAL AND PROCESS PIPING

A. Install seismic bracing for pipe runs meeting the following parameters:
   1. Fuel, medical gas and medical vacuum piping with diameters equal to or greater than 1 IN.
   2. Other piping (regardless of use) with diameters equal to or greater than 2-1/2 IN.

B. Trapeze assemblies supporting pipes shall be braced considering the total weight of the elements on the trapeze computed as pounds per lineal feet.

C. Unless an individual element or trapeze would otherwise require bracing, brace trapezes with a minimum weight in excess of 10 LBS per lineal foot.

D. For the purpose of calculating weight, piping is to be treated as full of water.

E. Locate seismic bracing no more than 10 FT from each main riser, at every piece of equipment, and at the entrance to the building.

F. Do not use branch lines to brace main lines.

G. At vertical pipe risers, wherever possible, support weight of riser at a point or points above center of gravity of riser.

H. Provide lateral guides at the top and bottom of the riser, and at intermediate points not exceeding 30 FT on center.

I. Bracing requirements and installation details for piping anchors and guides designed to accommodate thermal pipe movement are require custom analysis and design. Thermal pipe stress analysis and anchor /guide design shall be undertaken by a licensed engineer trained in thermal pipe stress analysis. Seismic forces and detail requirements as specified in this section shall be included in the design of such anchors and guides.

J. Individually supported pipes on rollers or hangers suspended from dual threaded rods shall employ a top roller in contact with the top of the pipe to prevent uplift during a seismic event.

3.3 HVAC DUCTWORK AND SUSPENDED HVAC EQUIPMENT

A. Install seismic bracing on HVAC ducts meeting the following parameters:
   1. Rectangular air handling ducts equal to or greater than 6 square feet in cross sectional area.
   2. All round air-handling ducts with diameters equal to or greater than 28 IN.

B. Trapeze assemblies supporting ducts shall be braced considering the total weight of the ducts on the trapeze.

C. Brace in-line equipment rigidly mounted to duct independently of duct work if unit weighs 50 LBS or more.
   1. If equipment is flexibly connected to the ductwork, independently brace equipment weighing 20 LBS or more.
   2. Mechanical piping connections to the equipment are to be flexible.
   3. Nearest transverse brace for connected duct shall be at a distance away from equipment of no more than 1/2 transverse brace spacing required.

D. Vertical duct runs mechanically attached to floors at a point of penetration may be considered as a transverse and longitudinal brace location provided anchorages and duct framing accommodate engineered load and provided distance to nearest 90 degree change in direction is no more than two duct widths.

E. Install a transverse brace on either side of a horizontal, ninety degree change in duct direction and within 10 FT of the end of a duct run

F. Vertical support rods are to be continuous from the lowest element of the duct or equipment support framing upward to the point of connection with anchorage to the structure. Rod couplers are permitted at the top of the rod for connection to deck anchorage.

3.4 FIRE PROTECTION PIPING

A. Install lateral, transverse, seismic bracing spaced no more than 40 FT on center on all feed and cross mains and branch lines and other piping 2-1/2 IN diameter and larger.

B. Install lateral, transverse, seismic bracing on last length of pipe and at end of a feed or cross main.
   1. Distance between end of pipe and last brace shall not exceed 20 FT.

C. Install longitudinal bracing maximum of 80 FT on center for feeds and cross mains.

D. Omit seismic bracing at sprinkler piping suspended by individual hangers 6 IN or less in length from top of pipe to bottom of structural attachment for hanger provided hanger rods are constructed in such a manner as to not produce bending in rod or attachment.

E. For purpose of calculating weight, treat piping as full of water.

F. Seismically brace tops of vertical riser piping using four way bracing.

3.5 FLOOR OR ROOF MOUNTED EQUIPMENT

A. Provide one mounting device on each leg or support with minimum three 3/8 IN diameter anchors.
   1. Do not include friction when designing anchors for shear.

B. Seismic forces shall be presumed to act through center of mass of equipment in direction producing largest single anchor force.

C. Calculate vertical seismic forces to act concurrently with horizontal seismic forces.

END OF SECTION

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SECTION 23 05 50
MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Mechanical Sound and Vibration Control, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Vibration isolators.
2. Bases.
3. Piping connections.

C. Definitions:
1. Seismic bracing or restraint; devices used to keep vibration isolated components in place during a seismic event.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM and AASHO standards.

1.3 SUBMITTALS

A. Shop Drawings:
1. Submit drawings for each piece of isolated equipment.
2. Include drawings of vibration isolators with equipment submittal. Include information specified in ANSI/ASA S2.8 or, at minimum, the following information:
   a. Isolator physical dimensions.
   b. Deflection.
   c. Compressed height.
   d. Solid height.
   e. Point location of each isolator.
   f. Calculated load at each point.
   g. Field static deflection.
   h. Calculated horizontal loading and bolt requirements.
   i. Indicate base clearance.
   j. Installation instructions and drawings.
   k. Detailed drawings showing location of seismic restraints including static and dynamic loading for coordination with supporting structure.
   l. Specific details of seismic restraints and anchors including number, size and location for each piece of equipment.

B. Product Data:
1. Vibration isolators, bases, and piping connections for equipment: Include with equipment submittal.
2. Vibration isolators, bases, and piping connections for applications other than equipment.
   a. Indicate specific applications with submittal.
3. Seismic restraint calculations stamped and signed by a registered Engineer licensed to practice Structural Engineering in the state where the job is located. Restraint or bracing devices shall have a pre-approval "OPA" number for California OSHPD or some other recognized government agency showing maximum restraint rating.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mechanical Sound and Vibration Control:
   1. Base:
      a. Mason Industries.
   2. Optional:
      a. Vibration Mountings and Controls.
      b. Vibration Eliminator.
      c. Korfund Dynamics.
      d. Amber/Booth.
      e. California Dynamics.
      f. Vibro-Acoustics.
      g. Kinetics Noise Control.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Provide piping and equipment isolation systems as specified.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.

C. Provide vibration isolation equipment including isolators, bases, and flexible piping connections from a single manufacturer of vibration isolation equipment.

D. Coat vibration isolation systems exposed to moisture and an outdoor environment as follows:
   1. Hot dip galvanize steel parts.
   2. Coat springs with neoprene.
   3. Cadmium plate hardware.

2.3 VIBRATION ISOLATORS

A. Neoprene Isolators:
   1. Type 1 seismic isolator: Same as Type 2 seismic isolator.
   2. Type 2 seismic isolator:
      a. Similar to ASHRAE Type D snubber.
      b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.
      c. Resilient seismic capability in every direction.
      d. Ductile-iron casting containing two separated and opposing molded neoprene elements with center threaded sleeve and adjustment bolt.
      e. Neoprene elements shall prevent center sleeve from contacting casting during normal operation.
      f. Neoprene: Bridge bearing.
   3. Type 2 isolator for suspended supports:
      a. Molded neoprene, double-deflection.
      b. Similar to ASHRAE Type 2 isolation hanger.
      c. Provide color coded neoprene-stock elements for easy identification of rated load capacity.
         1) Provide integral extension bushing on element where it contacts hanger frame to prevent metal to metal contact between frame and hanger rod.
      d. Provide hanger for direct attachment to flat iron duct straps.

B. Spring Isolators:
   1. Type 3 seismic isolator:
      a. Similar to ASHRAE Type C snubber.
      b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.

c. Free-standing, laterally stable spring isolator with ductile-iron housing and resilient snubbing collars.
d. Provide acoustical neoprene separator between spring(s) and base plate to prevent short circuiting through baseplate anchor bolts.
e. Resilient seismic capability in every direction.
   1) Snubbing shall occur in every direction with adjustment to limit upward, downward, and horizontal travel to a maximum of 1/4 IN.
f. Provide leveling bolts for rigid attachment to equipment.
g. Spring diameters: Not less than 0.8 of compressed height of spring at rated load.
h. Minimum additional travel of spring to solid: 50 PCT of rated deflection.
i. Provide ports in mounting for spring inspection.

2. Type 3 seismic isolator:
   a. Provide one snubbing component for each resilient component.
      1) Use either Type A or Type B snubbers, but use only one type on any one piece of equipment.
   b. Resilient component:
      1) Similar to ASHRAE Type 3 spring isolator.
      2) Free standing and laterally stable without housings, snubbers or guides.
      3) Provide 1/4 IN neoprene acoustical friction pads between baseplate and support.
      4) Provide leveling bolts for rigid attachment to equipment.
      5) Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
      6) Spring shall have minimum additional travel to solid equal to 50 PCT of rated deflection.
   c. Type A snubbing component:
      1) Similar to ASHRAE Type A snubber.
      2) Snubber shall have Anchorage Preapproval "OPA" number from California OSHPD.
      3) Restrains seismic movements in every direction.
      4) Interlocking steel members restrained by a neoprene bushing.
      5) Neoprene bushing: Bridge bearing, replaceable, minimum of 1/4 IN thick.
      6) Provide a minimum 1/8 IN air gap between resilient and rigid components of snubber attached to structure and equipment, respectively.
      7) Provide removable end cap to allow inspection of internal clearances.
   d. Type B snubbing component:
      1) Similar to ASHRAE Type B snubber.
      2) Snubber shall have Anchorage Preapproval "OPA" number from California OSHPD.
      3) Restrains seismic movements in every direction.
      4) Interlocking steel members restrained by a neoprene bushing.
      5) Neoprene bushing: Bridge bearing, replaceable, minimum of 1/4 IN thick.
      6) Provide a minimum 3/16 IN air gap between resilient and rigid components of snubber attached structure and equipment, respectively.
      7) Provide with factory installed spacers that maintain designed clearances during installation.

3. Type 3 isolator for suspended supports:
   a. Similar to ASHRAE Type 3 spring hanger.
   b. Provide Steel spring and neoprene cup element in series inside bottom of hanger frame.
      1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Provide integral extension bushing on neoprene element where it contacts hanger frame to prevent metal to metal contact between frame and hanger rod.
   d. Minimum additional spring travel to solid: 50 PCT of rated deflection.
   e. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.

4. Type 3N isolator for suspended supports:
   a. Similar to ASHRAE Type 3 spring hanger.
   b. Provide Steel spring and molded neoprene element in series inside bottom of hanger frame.
      1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Provide color coded neoprene-stock elements for easy identification of rated load capacity inside top of hanger frame.
   d. Provide integral extension bushing on neoprene elements where they contact hanger frame to prevent metal to metal contact between frame and hanger rod.
   e. Minimum additional spring travel to solid: 50 PCT of rated deflection.
   f. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.
5. Type 3P isolator for suspended supports:
   a. Similar to ASHRAE Type 3 spring hanger.
   b. Same as Type 3N except spring is precompressed to rated deflection so piping/equipment is maintained at a fixed elevation during installation.
   c. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
6. Type 4 seismic isolator:
   a. Similar to ASHRAE Type 4 restrained spring isolator.
   b. Isolator shall have Anchorage Preapproval "OPA" number from California OSHPD.
   c. Free-standing, laterally stable spring isolator.
   d. Provide resilient vertical limit restraints to prevent spring extension during weight changes.
      1) During normal operation, restraints shall not contact spring assembly.
   e. Provide acoustical neoprene separator between spring(s) and base plate to prevent short circuiting through baseplate anchor bolts.
   f. Installed height shall equal operating height.
   g. Provide Resilient seismic capability in every direction.
      1) Snubbing shall occur in all directions with adjustment to limit upward, downward, and horizontal travel to a maximum of 1/4 IN.
7. Type 5 thrust restraint:
   a. Similar to ASHRAE Type 5 thrust restraint.
   b. Same as Type 3 isolator for suspended supports except with angle-iron and rod attachments configured for mounting across flexible duct connection.

2.4 BASES

A. Bases:
1. Type B, structural steel base:
   a. Rectangular in shape except for equipment which may require "T" or "L" shaped bases.
   b. Bases for split case pumps:
      1) Provide supports for suction and discharge base ells.
      2) Size base large enough to support base-ell supports.
   c. Perimeter members: Beams with a minimum depth equal to 0.10 of longest dimension of base.
   d. Beam depth need not exceed 14 IN provided that deflection and misalignment is kept within acceptable limits as determined by manufacturer.
   e. Provide height saving brackets in mounting locations to provide a base clearance of 1 IN.
2. Type C, concrete-filled, structural steel base:
   a. Rectangular structural beam or channel concrete forms for floating foundations.
   b. Minimum base depth: 0.083 of longest dimension of base, but not less than 6 IN.

c. Base depth need not exceed 12 IN unless specially recommended by base manufacturer for mass or rigidity.
d. Bases for split case pumps:
1) Provide supports for suction and discharge base ells.
2) Size base large enough to support base-ell supports.
e. Provide minimum concrete reinforcement consisting of 1/2 IN bars or angles welded in place on 6 IN centers running both ways in a layer 1-1/2 IN above bottom, or additional steel as is required by structural conditions.
f. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
g. Provide height saving brackets in mounting locations to maintain a 1 IN clearance below base.

3. Type D, curb mounted base:
a. Factory assembled isolation base that fits over roof curb and under isolated equipment.
b. Provide extruded aluminum top member to overlap bottom member to provide water run off independent of seal.
c. Provide Type 3 isolators integral with base.
1) Minimum deflection: 1.5 IN.
d. Design shall allow springs to be inspected, serviced, and changed out while disturbing neither the roofing nor the unit.
e. Provide resilient snubbers in corners with minimum clearance of 1/4 IN for wind resistance.
f. Provide a weather seal of continuous closed cell sponge material both above and below base and a waterproof flexible duct-like EPDM connection joining outside perimeter of aluminum members.
g. Foam or other contact seals are not acceptable at spring cavity closure.

4. Type E, roof pedestal or curb: See Section 07 72 13.
5. Type IP, field assembled concrete base:
a. Isolation bases:
1) Field assembled concrete pads provided by Contractor.
2) See Division 03 and structural drawings.
3) See Contractor provided anchorage submittal package.

2.5 PIPING CONNECTIONS

A. Pipe Connections:
1. Flexible pipe connectors (FPC):
a. Flexible neoprene/EPDM:
1) Straight connectors: Twin sphere type.
2) Elbow connectors: Single sphere type.
b. Multiple plys of friction nylon tire cord with EPDM cover and liner.
c. Do not use steel wire or rings as pressure reinforcement.
d. Connectors:
1) 2 IN NPS and smaller: Threaded or flanged ends.
2) 2-1/2 IN NPS and larger: Floating galvanized steel flanges.
e. Minimum pressure ratings:
1) Twin spheres: 250 PSI at 170 DEGF and 165 PSI at 250 DEGF.
2) Elbows and reducing twin spheres: 220 PSI at 170 DEGF and 145 PSI at 250 DEGF.

2. Flexible pipe hoses (FPH):
a. Braided, stainless-steel type.
b. Stainless steel braid: Type 321.
c. Fittings: Carbon steel.
d. Connections:
1) 2-1/2 IN NPS and smaller: Male nipples or copper sweat to match specified piping joints.

2) 3 IN NPS and larger: Flanged.

e. Minimum transverse motion: ± 3/8 IN with no permanent misalignment.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL

A. Install vibration control equipment in accordance with manufacturer's installation instructions and as specified.

B. Select vibration control equipment as specified, and size in accordance with weight distribution, pull, and torque imposed by equipment being isolated.
1. Base selection on equipment with Architect approved submittals.
2. Minimum static deflections may be revised subject to prior approval.

C. Provide revised vibration control equipment to match revised or substituted equipment.

3.2 SEISMIC ISOLATORS

A. Do final positioning and adjusting of isolators after equipment is fully operational and while it is running.

3.3 VIBRATION ISOLATORS, BASES, AND PIPING CONNECTIONS

A. Provide vibration isolators, bases, and piping connections as indicated in the following tables.
1. Superscript numbers in parentheses refer to notes at the end of the tables.
2. Isolators shall be specified by specialty structural engineer with seismic bracing calculations and details. Specific isolator shall be selected suitable for individual equipment weight and operation.

MOUNTED ON GRADE SUPPORTED SLAB					
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Pipe Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blowers/Fans			n/a
Air Handling Units With external (blower)isolation	All	3	0.75 IN	none	Note 14
Air Compressors & Vacuum Pumps (8)					
Tank Mounted					
Horizontal	Up to 10 HP	3	0.75 IN	none	FPH
Horizontal	15 HP & Up	3	0.75 IN	C	FPH
Vertical	All	3	0.75 IN	C	FPH
Base Mounted	All	3	0.75 IN	C	FPH
Large Reciprocating	All	3	0.75 IN	C	FPH
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)					
Up to 22 IN	All	2	0.25 IN	B	n/a
24 IN and Up					
301 to 500 RPM	Up to 40 HP	3 & 5	1.50 IN	B	n/a
Above 500 RPM	Up to 40 HP	3 & 5	0.75 IN	B	n/a
301 to 500 RPM	50 HP & Up	3 & 5	1.50 IN	C	n/a
Above 500 RPM	50 HP & Up	3 & 5	1.00 IN	C	n/a
Boilers	All	1	0.25 IN	IP	none
Chillers					

Absorption	All	1	0.25 IN	IP	FPC
Centrifugal	All	1	0.25 IN	C	FPC
Reciprocating	All	2	0.25 IN	IP	FPC
Screw	All	1	0.25 IN	IP	FPC
Cooling Towers					
301 to 500 RPM	All	1	0.25 IN	none	none
Above 500 RPM	All	1	0.25 IN	none	none
Fluid Coolers					
Outdoors	All	1	0.25 IN	none	none
Indoors	All	1	0.25 IN	IP	FPC
Fans, Axial (2,3)					
Up to 22 IN	All	2 & 5	0.25 IN	none	n/a
24 IN and Up					
301 to 500 RPM	Up to 2 IN. S.P.	3 & 5	0.75 IN	B	n/a
Above 500 RPM	Up to 2 IN. S.P.	3 & 5	0.75 IN	B	n/a
301 to 500 RPM	2.1 IN. S.P. & Up	3 & 5	1.50 IN	C	n/a
Above 500 RPM	2.1 IN. S.P. & Up	3 & 5	0.75 IN	C	n/a
Flue Gas Economizers	All	none	---	IP	n/a
Fuel Oil Pumps	All	none	---	IP	n/a
Incinerators	All	1	0.25 IN	IP	n/a
Piping	All	4	1.50 IN	none	none
Pumps					
Close Coupled	Up to 7.5 HP	2	0.25 IN	B	FPC
	10 HP & Up	3	0.75 IN	B	FPC
Flex Coupled	Up to 40 HP	3	0.75 IN	B	FPC
	OVER 50 HP	3	0.75 IN	C	FPC
Large Inline	5 to 25 HP	3	0.75 IN	none	FPC
	30 HP & Up	3	0.75 IN	none	FPC
End Suction & Split Case	Up to 40 HP	3	0.75 IN	C	FPC
	50 to 125 HP	3	0.75 IN	C	FPC
	150 HP & Up	3	0.75 IN	C	FPC
Grouped On Base	All	1	0.30 IN	IP	FPC
Packaged Systems (8)	All	3	0.75 IN	C	FPC
Thermal Storage Systems	All	none	---	IP	none

MOUNTED ON STRUCTURAL FLOOR

Equipment	Horsepower & Other	21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blower/Fans			See Blower/Fans			n/a
Air Handling Units With external (blower) isolation	All	3	1.50 IN	C	3	2.50 IN	C	Note 14
Air Compressors & Vacuum Pumps (8)								
Tank Mounted								
Horizontal	Up to 10 HP	3	1.50 IN	none	3	1.50 IN	none	FPH
Horizontal	15 HP & Up	3	1.50 IN	C	3	1.50 IN	C	FPH

Vertical	All	3	1.50 IN	C	3	1.50 IN	C	FPH
Base Mounted	All	3	1.50 IN	C	3	1.50 IN	C	FPH
Large Reciprocating	All	3	1.50 IN	C	3	1.50 IN	C	FPH
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)								
Up to 22 IN	All	3 & 5	0.75 IN	B	3 & 5	1.50 IN	C	n/a
24 IN and Up								
301 to 500 RPM	Up to 40 HP	3 & 5	2.50 IN	B	3 & 5	2.50 IN	B	n/a
Above 500 RPM	Up to 40 HP	3 & 5	0.75 IN	B	3 & 5	1.50 IN	B	n/a
301 to 500 RPM	50 HP & Up	3 & 5	2.50 IN	C	3 & 5	2.50 IN	C	n/a
Above 500 RPM	50 HP & Up	3 & 5	1.50 IN	C	3 & 5	2.50 IN	C	n/a
Boilers	All	4	1.50 IN	B	4	2.50 IN	B	none
Chillers								
Absorption	All	4	1.50 IN	none	4	1.50 IN	none	FPC
Centrifugal	All	4	1.50 IN	C	4	1.50 IN	C	FPC
Reciprocating	All	4	1.50 IN	none	4	2.50 IN	none	FPC
Screw	All	4	1.50 IN	none	4	1.50 IN	none	FPC
Cooling Towers								
301 to 500 RPM	All	4	2.50 IN	none	4	2.50 IN	none	FPC
Above 500 RPM	All	4	0.75 IN	none	4	1.50 IN	none	FPC
Fluid Coolers								
301 to 500 RPM	All	4	2.50 IN	none	4	2.50 IN	none	FPC
Above 500 RPM	All	4	0.75 IN	none	4	1.50 IN	none	FPC
Fans, Axial (2,3)								
Up to 22 IN	All	3 & 5	0.75 IN	none	3 & 5	0.75 IN	C	n/a
24 IN and Up								
301 to 500 RPM	Up to 2 IN. S.P.	3 & 5	2.50 IN	C	3 & 5	2.50 IN	C	n/a
Above 500 RPM	Up to 2 IN. S.P.	3 & 5	1.50 IN	B	3 & 5	1.50 IN	B	n/a
301 to 500 RPM	2.1 IN. S.P. & Up	3 & 5	2.50 IN	C	3 & 5	2.50 IN	C	n/a
Above 500 RPM	2.1 IN. S.P. & Up	3 & 5	1.50 IN	C	3 & 5	2.50 IN	C	n/a
Incinerators	All	4	1.50 IN	B	4	2.50 IN	B	none
Piping (9) First 3 supports from equipment connection	All	3	Note 11	none	3	Note 11	none	n/a
Remaining supports within 50 FT of equipment connection	All	3	0.75 IN	none	3	0.75 IN	none	n/a
Pumps								
Close Coupled	Up to 7.5 HP	3	0.75 IN	B	3	0.75 IN	C	FPC
	10 HP & Up	3	1.50 IN	B	3	1.50 IN	C	FPC
Flex Coupled	Up to 40 HP	3	1.50 IN	B	3	1.50 IN	C	FPC
	50 to 125 HP	3	1.50 IN	C	3	2.50 IN	C	FPC
	Over 125 HP	3	3.5 IN	C	-	-	-	-
Large Inline	5 to 25 HP	3	1.50 IN	none	3	1.50 IN	none	FPC
	30 HP & Up	3	1.50 IN	none	3	2.50 IN	none	FPC
End Suction & Split Case	Up to 40 HP	3	1.50 IN	C	3	1.50 IN	C	FPC
	50 to 125 HP	3	1.50 IN	C	3	2.50 IN	C	FPC

	150 HP & Up	3	2.50 IN	C	3	3.50 IN	C	FPC
Packaged Systems (8)	All	3	1.50 IN	C	3	2.50 IN	C	FPC

SUSPENDED FROM STRUCTURE

Equipment	Horsepower & Other	21 TO 30 FT FLOOR SPAN Isolator Type	Minimum Deflection	Base Type	31 T0 40 FT FLOOR SPAN Isolator Type	Minimum Deflection	Base Type	Pipe Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blower/Fans			See Blowers/Fans			n/a
Air Handling Units With external (blower) isolation	All	3	1.50 IN	C	3	2.50 IN	C	Note 14
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)								
Up to 22 IN	All	3 & 5	0.75 IN	B	3 & 5	1.50 IN	C	n/a
24 IN and Up								
301 to 500 RPM	Up to 40 HP	3 & 5	2.50 IN	B	3 & 5	2.50 IN	B	n/a
Above 500 RPM	Up to 40 HP	3 & 5	0.75 IN	B	3 & 5	1.50 IN	B	n/a
301 to 500 RPM	50 HP & Up	3 & 5	2.50 IN	C	3 & 5	2.50 IN	C	n/a
Above 500 RPM	50 HP & Up	3 & 5	1.50 IN	C	3 & 5	2.50 IN	C	n/a
Fans, Axial (2,3)								
Up to 22 IN	All	3 & 5	0.75 IN	none	3	0.75 IN	C	n/a
24 IN and Up								
301 to 500 RPM	Up to 2 IN. S.P.	3 & 5	2.50 IN	C	3	2.50 IN	C	n/a
Above 500 RPM	Up to 2 IN. S.P.	3 & 5	1.50 IN	B	3	1.50 IN	B	n/a
301 to 500 RPM	2.1 IN. S.P. & Up	3 & 5	2.50 IN	C	3	2.50 IN	C	n/a
Above 500 RPM	2.1 IN. S.P. & Up	3 & 5	1.50 IN	C	3	2.50 IN	C	n/a
Fans, Inline (2,3)	Up to 0.5 HP	3 or 3N	0.50 IN	none	3 or 3N	0.50 IN	none	n/a
	0.75 to 3 HP	3 or 3N	0.75 IN	none	3 or 3N	0.75 IN	none	n/a
	5 to 7.5 HP	3 or 3P & 5	1.50 IN	none	3 or 3P & 5	1.50 IN	none	n/a
	10 HP & Up	3 or 3P & 5	1.50 IN	none	3 or 3P & 5	2.50 IN	none	n/a
	10 HP & Up	3 or 3N & 5	1.50 IN	none	3 or 3N & 5	2.50 IN	none	n/a
Fans Coil Units	Up to 0.5 HP	2	0.50 IN	none	2	0.50 IN	none	FPC
	0.75 to 1.0 HP	3 or 3N	0.75 IN	none	3 or 3N	0.75 IN	none	FPC
	1.5 HP & Up	3 or 3P	0.75 IN	none	3 or 3P	1.50 IN	none	FPC
Piping (9) First 3 supports from equipment	All	3P	Note 11	none	3P	Note 11	none	n/a
connection Remaining supports within 50 FT of								
equipment connection								
Suspended Individually	Up to 3 IN	3N	0.75 IN	none	3N	0.75 IN	none	n/a

	4 IN & Up	3P	0.75 IN	none	3P	0.75 IN	none	n/a
Suspended on Trapeze	All	3P	1.50 IN	none	3P	1.50 IN	none	n/a
	All	3N	2.50 IN	none	3N	2.50 IN	none	n/a
Piping in Mechanical Rooms and Sensitive Areas (10,12,15)								
	Up to 3 IN	3N	0.75 IN	none	3N	0.75 IN	none	n/a
	4 to 6 IN	3P	1.50 IN	none	3P	1.50 IN	none	n/a
	8 IN & Up	3P	1.50 IN	none	3P	1.50 IN	none	n/a
	8 IN & Up	3N	2.50 IN	none	3N	2.50 IN	none	n/a
Piping at Building Expansion and Seismic Joints								
Nonflammable Gases (non-medical)	All	n/a	n/a	none	n/a	n/a	none	FPH or Loop
Potable Water	All	n/a	n/a	none	n/a	n/a	none	FPC or Loop
Other Systems	All	n/a	n/a	none	n/a	n/a	none	loop
Piping at Plenum Penetrations	All	n/a	n/a	none	n/a	n/a	none	Note 14
Pumps								
Inline	Up to 2 HP	3 or 3N	0.75 IN	none	3 or 3N	0.75 IN	none	FPC
	3 to 5 HP	3 or 3P	1.50 IN	none	3 or 3P	1.50 IN	none	FPC
	7.5 HP & Up	3 or 3P	1.50 IN	none	3 or 3P	1.50 IN	none	FPC
	7.5 HP & Up	3 or 3N	2.50 IN	none	3 or 3N	2.50 IN	none	FPC

MOUNTED ON ROOF								
		21 TO 30 FT FLOOR SPAN			31 T0 40 FT FLOOR SPAN			Pipe
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Air Conditioning Units								
External	Less than 50 Tons	3 locked out	1.50 IN (13)	D & E	3 locked out	1.50 IN (13)	D & E	Note 14
Internal			---	B		---	B	n/a
External	50 Tons & Up	3 locked out	2.50 IN (13)	D & E	3 locked out	2.50 IN (13)	D & E	Note 14
Internal			---	B		---	B	n/a
Blowers/Fans								
Externally Isolated	Up to 5 HP	3	0.75 IN	E	3	0.75 IN	E	n/a
	7.5 HP & Up	3	1.50 IN	E	3	1.50 IN	E	n/a
Internally Isolated	Up to 10 HP	3	0.75 IN	E	3	1.50 IN	E	n/a
Condensers and Condensing Units								
Less than 25 Tons		4	1.50 IN	E	4	1.50 IN	E	Note 14
25 Tons & Up		4	2.00 IN	E	4	2.00 IN	E	Note 14
Cooling Towers and Fluid Coolers								
301 to 500 RPM	All	4	2.50 IN	none	4	2.50 IN	none	FPC
Above 500 RPM	All	4	0.75 IN	none	4	1.50 IN	none	FPC

B. Notes to Tables:
   1. Install piping connectors on equipment side of equipment isolation valves.
   2. Size indicates diameter of wheel.
   3. Provide Type 5 isolators on units operating at 2 IN or more static pressure.
      a. Mount one pair of isolators (on opposite sides) on each of fan's flexible connections.
      b. Adjust isolators to prevent flexible connections from extending to a tension condition.
      c. Attach isolators to duct at flanged joint through angle iron on back side of joint.
      d. See Section 23 31 13.

4. A swing joint with three flexible mechanical groove couplings may be substituted for an FPC.
5. Spring diameter: 2.50 IN.
6. Spring diameter: 4 IN.
7. Spring diameter: 6 IN.
8. On packaged systems, provide only external isolation.
9. Provide isolators on piping connected to vibrating equipment (i.e., equipment for which piping connections are specified).
10. Provide isolators for drainage and vent piping only if connected to vibrating equipment.
11. Same type as specified for equipment, except minimum deflection is 0.75 IN, and maximum deflection is 2.00 IN.
12. Mechanical rooms and sensitive areas:
    a. Mechanical rooms:
        1) Provide isolators for piping within mechanical rooms.
        2) Where isolators are indicated for piping connected to vibrating equipment, provide isolators which have the largest indicated minimum deflections.
    b. Sensitive areas:
        1) Operating rooms.
13. Integral with base D.
14. Piping connection types:
    a. Water: FPC.
    b. Steam and refrigerant: FPH.

END OF SECTION

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SECTION 23 11 23
NATURAL GAS PIPING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Natural Gas Piping System, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Piping standards: See Section 20 11 00.

B. Manual valve standards: See Section 20 05 23 (for valves labeled "V-__").

1.3 SUBMITTALS

A. Product Data:
   1. Piping, fittings, devices, and valves.
   2. Pressure regulators.
   3. Gas meters.

B. Contract Closeout Information:
   1. Test reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe wrapping:
   1. Base:
      a. Republic.

B. Pipe field wrap:
   1. Base:
      a. Republic.

C. Gas Regulators:
   1. Base:
      a. Fisher Regulators.
   2. Optional:
      a. Maxitrol Company.
      b. American Meter Company.

D. Gas Meters:
   1. Base:
   2. Optional:
      a. Equimeter.
      b. American Meter Company.
      c. Invensys.

E. Earthquake Valves:
   1. Base:
   2. Optional:
      a. Pacific Seismic Products, Inc.
      b. Quake Defense, Inc.

c. Strand Earthquake.

F. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Natural Gas Piping
1. Gas piping above ground:
   a. Black steel.
   b. 2 IN and smaller: Welded joints, with socket welding fittings.
   c. 2 IN and smaller, exposed in mechanical rooms or outdoors: Black malleable threaded fittings.
   d. 2 1/2 and larger: Welded joints, with butt welding fittings.
2. Pipe wrapping for black steel piping: Factory installed, Republic X-Tru-Coat.
3. Pipe field wrap for black steel piping: Republic X-Tru-Tape, 1 IN and less wide.

B. Valves
1. Ball valves (2 IN and smaller): V-16.
2. Plug valves:
   a. 2 IN and smaller: V-60.
   b. 2-1/2 IN and larger: V-41.

C. DN50Gas Pressure Regulators
1. Provide gas pressure regulators where the gas supply pressure is higher than the pressure at which the gas utilization equipment is designed to operate.
2. Gas pressure regulators shall be designed for a maximum pressure drop of 0.25 PSIG at maximum flow.Provide at service entrance or as shown on the drawings.
3. Equipment capacities: As shown / scheduled.
   a. Natural gas at 1000 BTUH per CU FT.

D. Gas Meters
1. Die cast aluminum alloy factory painted.
2. Pressure and temperature compensated. Bi-metallic element that automatically corrects changes in gas temperature.
3. UV stabilized clear polycarbonate index box to measure consumption in cubic feet.
4. Provide meters that can be remotely read by building's energy management system.
   a. They shall read both gas; instantaneous flow rate in cubic feet per minute; and consumption in cubic feet; and be compatible with remote reading systems (pulse type).
   b. Coordinate with Control Provider.

E. Earthquake Valves
1. Comply with ASCE 25.
2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. 60 PSI maximum operating pressure.
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves 2 IN and smaller; flanged for valves 2-1/2 IN and larger.

PART 3 - EXECUTION

3.1 NATURAL GAS PIPING INSTALLATION

A. Install in accordance with codes, local Gas Company regulations and ordinances.

B. Provide new service regulator and meter.

C. Provide earthquake emergency gas shut-off valves at each service to a building.

D. Vent regulators in accordance with NFPA 54, International Fuel Gas Code, and Authority Having Jurisdiction. For regulators installed inside the building, manhole, or in an enclosed space extend vent piping full size from the regulator to the exterior of the building or provide approved vent limiting devices in accordance with ANSI Z21.80 and CSA 6.22.

E. All piping running up on the outside of walls shall be secured by pipe standoffs.

F. Provide shut-off valves, dirt leg, and unions on all appliances and equipment.

G. Provide shut-off valves before every gas pressure regulator.

H. Where flexible connections are required, they shall be CSA approved.

I. Provide an approved permanent tag or label that identifies the pressure upstream of all gas regulators.

3.2 TESTING

A. Before piping is concealed, test system in presence of Owners Representative.

B. Perform a 100 PSI air test for 6 HRS without pressure drop.

END OF SECTION

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SECTION 23 21 13
HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Hydronic Piping Systems, as indicated, in accordance with provisions of Contract Documents.

B. Systems and Products Included:
   1. Systems:
      a. Chilled water and Equipment Cooling water piping.
      b. Heating water piping.
      c. Make-up water piping.
   2. Products:
      a. Air vents.
      b. Duct mounted coils.
      c. Expansion tanks.
      d. Pressure and temperature test stations, combination.
      e. Air Eliminators and Dirt Separators.
      f. Strainers.
      g. Valves.
      h. Water treatment system.

C. Work installed but not furnished:
   1. Automatic valves: Furnished in Section 25 50 00.
      a. Provide fittings and reducers required for installation of automatic valves.
   2. Electronic flow measurement devices: Furnished in Section 25 50 00.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Piping standards: Section 20 11 00.

B. Manual valve standards: Section 20 05 23 (for valves with "V" prefix).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Piping layouts at 1/4 IN/FT scale.

B. Product Data:
   1. Air vents.
   2. Duct mounted coils.
   3. Expansion tanks.
   4. Pressure and temperature test stations, combination.
   5. Air Eliminator and Dirt Separators.
   6. Strainers.
   7. Valves, constant flow control.
   8. Valves, manual.

C. Contract Closeout Information:
   1. Operation and Maintenance Data for items requiring operational instructions or periodic maintenance such as: air vents, constant flow control valves, pressure relief valves, triple

duty valves, water flow measurement devices, water treatment system, glycol feed systems, etc.

2. Field test reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Automatic High Capacity Air Vents:
   1. Base:
   2. Optional:
      a. Hoffman Specialty.
      b. Armstrong International.
      c. Metraflex.
      d. Thrush.

B. Automatic Low Capacity Air Vents:
   1. Base:
      a. Hoffman Air & Filtration Systems.
   2. Optional:
      a. Armstrong International.
      b. Bell & Gossett, ITT.
      c. Taco.
      d. Thrush.

C. Manual Air Vents:
   1. Base:
   2. Optional:
      a. Crane Valves.
      b. Jenkins.
      c. Johnston.
      d. OIC.
      e. Powell.
      f. Stockham Valves & Fittings.

D. Expansion Tanks:
   1. Base:
   2. Optional:
      a. Armstrong Pumps.
      b. Bell & Gossett, ITT.
      c. Taco.
      d. Thrush.

E. Pressure/Temperature Test Stations, Combination P/T Plug.
   1. Base:
   2. Optional:
      a. Fairfax.
      b. P/T Plugs and Flex Connectors by Sisco.
      c. Super Seal.

F. Air Eliminator and Dirt Separators:
   1. Base:
   2. Optional:
      a. Armstrong International.
      b. Bell & Gossett, ITT.
      c. Spirotherm.
      d. Taco.

G. In-line Wye Strainer and Valve Combination Strainers:
1. Base:
2. Optional:
a. Flow Design Inc.
b. Griswold Controls.
c. Nexus Valve.

H. Suction Diffuser Strainers:
1. Base:
2. Optional:
a. Armstrong Pumps.
b. Bell & Gossett, ITT.
c. Mueller Steam Specialty.
d. Taco.
e. Victaulic of America.

I. Constant Flow Control Valves:
1. Base:
2. Optional:
a. Flow Design Inc..
b. Griswold Controls.
c. Nexus Valve.

J. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Pipe And Fittings:
1. Pipe and fittings - General:
a. The following are not permitted:
1) Plain end, pressure fit type fittings.
2) Hole cut mechanical tee or saddle fittings.
2. Fittings: galvanized where galvanized piping is used.
3. Chilled water and Equipment Cooling water piping, above grade:
a. Copper, type L, with soldered joints, and wrought copper or cast brass fitting.
b. Black steel, schedule 40.
1) 2 IN and smaller: Threaded joints, with cast iron or malleable iron threaded fittings.
2) 2-1/2 IN and larger: Welded joints.
c. Inside fan plenums (and piping from coil connections to piping headers inside and outside of plenums):
1) Copper, type L, with soldered joints, and wrought copper or cast brass fittings.
2) Black steel, with grooved couplings and fittings.
4. Condensate and cooling-coil-drain piping:
a. Copper, type L, with soldered joints.
5. Heating water piping, above grade:
a. Copper, type L, with soldered joints, and wrought copper or cast brass fittings.
b. Black steel, schedule 40, with welded joints.
1) For 2-1/2 IN and larger: Use butt welding fittings.
2) For 2 IN and less: Use socket welding fittings, 2000 PSI class, malleable or cast iron threaded fittings.
3) Weld-o-let or thread-o-let type fittings may be used in lieu of tees for branch connections, provided main is one size larger than takeoff. Couplings or half couplings are not acceptable except for non-flow connections such as thermometers or gauges.
6. Make-up water piping:
a. Same as system served.

B. Air Vents:
   1. High Capacity, automatic:
      a. 300 PSI rated test pressure, minimum.
      b. Maximum working pressure: 150 PSIG.
      c. Maximum temperature: 212 DEGF.
      d. Body and cover material: Cast iron, ASTM-A126, Class B.
      e. Seat material: Stainless steel-T303, ASTM-A276 or Viton.
      f. Float and float arm material: Stainless steel-T304, ASTM-A240.
   2. Low Capacity, automatic:
      a. 150 PSI rated, minimum.
      b. Maximum working pressure: 100 PSIG.
      c. Maximum temperature: 212 DEGF.
      d. Cast bronze, chrome plated, body with renewable valve and seat.
      e. Synthetic rubber disc.
   3. Air vents, manual:
      a. Vent valves: 1/4 IN 125 PSI globe angle valve with XH nipple connecting to pipe.

C. Duct Mounted Coils:
   1. Coils, general: AHRI Standard 410.
      a. Each coil to bear AHRI certification label.
   2. Coils, cooling and heating:
      a. Continuous plate, for 200 PSI operating pressure.
      b. Capacity: As scheduled.
      c. Headers: Cast iron, copper or brass.
      d. Fins:
         1) Aluminum.
         2) 10 fins per IN maximum.
      e. Tubes: Copper, arrange for counter-flow of air and water.
      f. Water velocity: 8 FPS maximum with head loss not greater than scheduled.
      g. Provide 16 ga galvanized steel casing with provision for bolting heating coils to ductwork.
      h. Provide air vent and system drain at high and low points, respectively, of each coil. See Section 20 05 19.
      i. Coils guaranteed to drain.

D. Expansion Tanks:
   1. Tanks, expansion (air-elimination system):
      a. Pre-pressurized bladder type.
      b. Size: As scheduled.
      c. Rated pressure: 125 PSIG.
      d. Rated operating temperature: 240 DEGF, minimum.
      e. Precharge pressure: Same as scheduled minimum operating pressure.
      f. Bladder: Heavy duty butyl, removable for inspection.
      g. ASME constructed and stamped.

E. Pressure and Temperature Test Stations, Combination:
   1. Pressure/temperature test station, combination:
      a. Station to receive either a 1/8 IN OD temperature or pressure probe.
      b. Fitting: Solid brass, 1/4 IN NPT, with 2 valve cores of neoprene (maximum 200 DEGF at 500 PSI) or Nordel (maximum 275 DEGF at 500 PSI).
      c. Provide extension at locations with pipe insulation. Extension length shall match or exceed insulation thickness.
      d. Provide with color coded and marked cap with gasket, rated at 1000 PSI at 140 DEGF.

F. Air Eliminators and Dirt Separators:
   1. Air eliminators and dirt separators:
      a. Coalescing type air eliminator and dirt separator.

b. Shell: Fabricated Steel.
c. Seals: Viton.
d. Removable stainless steel or copper wound air/dirt collection medium.
e. An integral full port float actuated brass venting mechanism shall be installed at the top of the venting chamber.
f. Design pressure: 150 PSIG.
g. NPT tappings for vent and blowdown connections.
h. Air Removal Efficiency: 100 PCT free and entrained air and 99.6 PCT dissolved air.
i. Dirt Removal Efficiency: 80 PCT of all particles 30 microns and larger within 100 passes.
j. Removable lower head to facilitate removal of internal assembly for inspection

G. Strainers:
1. Strainers, suction diffusers:
a. Angle cast iron body type with inlet vanes and combination diffuser-strainer-orifice cylinder.
b. Provide with disposable 16 mesh strainer for system start-up.
c. Orifice cylinder with 3/16 IN diameter openings.
1) Designed to withstand pressure differential equal to pump shutoff head (maximum 175 PSI).
2) Free area equal to 5 times cross-section area of pump suction opening.
d. Vane length: Not less than 2-1/2 times pump suction opening.
1) Provide with adjustable support foot to carry weight of suction piping.
2. Strainers, wye:
a. See Section 20 05 19, Piping Specialties.

H. Valves
1. Constant flow control valves:
a. Factory calibrated, direct acting, automatic pressure compensating.
b. Control flow rates within 4 percent of flow rating over operating pressure differential range.
1) Set flow rating to match the maximum flow required by device served.
c. Pressure differential range:
1) 2-32 PSID.
d. Threaded-brass or copper-sweat body with stainless-steel internal parts.
e. Provide a metal identification tag with chain for each installed valve.
1) Identify valve model number, rated GPM, direction of flow, and differential pressure range.
f. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.
g. Provide as indicated.
2. Manual valves:
a. Angle valves:
1) 2 IN and smaller: V-17.
2) 2-1/2 IN and larger: V-18.
b. Balancing valves:
1) 2 IN and smaller: V-64.
2) 2-1/2 IN to 12 IN: V-65.
3) Ball type balancing valves/circuit setters shall not be used.
c. Isolation valves (Ball valves):
1) 2 IN and smaller: V-13 or V-14.
d. Isolation valves (Butterfly valves):
1) 2 IN and smaller: not used.
2) 2-1/2 IN and larger: V-34 or V-35.
e. Check valves, pump discharge:
1) 2 IN and smaller: V-25 or V-26.

2) 2-1/2 IN and larger: V-28, V-29, or V-30.

f. Check valves, other:
1) 2 IN and smaller: V-25.
2) 2-1/2 IN and larger: V-28 or V-29.

g. Isolation valves (Gate valves):
1) 2 IN and smaller: not used.
2) 2-1/2 IN and larger: V-3.

h. Globe valves:
1) 2 IN and smaller: V-6 or V-7.
2) 2-1/2 IN and larger: V-8.

i. Plug valves:
1) 2 IN and smaller: V-36.
2) 2-1/2 IN and larger: V-37.

3. Pressure relief valves, water:
a. ASME-approved, tight-shutoff, self-closing.
b. 2-1/2 IN and less: Screwed.
c. 3 IN and larger: Flanged.
d. 10 PCT over pressure.
e. Test lever.

2.3 WATER TREATMENT SYSTEM

A. Water Treatment-system chemical feeders:
1. Pot type feeders constructed for operating pressure of 150 PSI.
2. Capacity of feeders: 3 GAL minimum.

2.4 VIBRATION ISOLATION

A. Vibration Isolation: Section 20 05 50.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with Section 20 11 00 and Section 20 05 00.

B. Connect equipment.

3.2 PIPE AND FITTINGS

A. Do not insulate or conceal piping until testing is completed.

3.3 AIR VENTS

A. Automatic Air Vents:
1. Provide shut off valve ahead of vent.
2. Provide copper relief line from valve to drain or drip pan.
3. Provide low capacity at all piping high points.
4. Provide high capacity at locations indicated on equipment and piping schematic drawings.

B. Air Vents, manual:
1. Vents shall prevent air binding in systems.
2. Vent valves:
a. Provide at trapped high points of closed cooling and heating piping systems.
b. Provide at coil headers in air handling units unless an automatic air vent is indicated at that location on equipment or piping schematic drawings.

3. Coin operated vents:
   a. May be used in lieu of vent valves at coil headers for terminal units with piping connections 1-1/4 IN and smaller.

3.4 PRESSURE AND TEMPERATURE TEST STATIONS, COMBINATION

A. Provide at locations indicated on equipment and piping schematic drawings.

3.5 AIR ELIMINATORS AND DIRT SEPARATORS

A. Provide at locations indicated on equipment and piping schematic drawings.

3.6 STRAINERS

A. Provide full line size strainers ahead of control valves (motor operated), regulating valves, pumps, and as indicated.

B. Provide strainer types as indicated:
   1. Chilled water: Single-basket, tee, or wye type.
   2. Heating water: Single-basket, tee, or wye type.

C. Connections to suit piping.

D. Provide blow-down valves:
   1. Strainers 6 IN and larger: 1-1/2 IN blow-down valve.
      a. Pipe blow down to drain.
   2. Strainers 2 to 5 IN: 1 IN blow-down valve with 3/4 IN hose end connection.
   3. Strainers 1-1/2 IN and smaller: 1/2 IN blow-down valve with 3/4 IN hose end connection.

3.7 VALVES

A. Heating and cooling pipe risers:
   1. Provide isolation valves at main feed points to risers.
   2. Provide isolation valves at branch take-offs from risers.

B. Install pressure relief valves on heat exchangers' piping between exchanger and isolation valves.

C. Provide drain piping at pressure relief valves and valves with test levers.
   1. Extend piping to within 6 IN of floor.

D. System Drains: See Section 20 05 19.

3.8 WATER TREATMENT SYSTEM

A. Mount chemical feeder across balance valve on pump discharge of systems.
   1. Heating water system.

3.9 CONDENSATE DRAINS

A. Pipe condensate drains for all equipment (i.e. air handling units, fan coil units, kitchen condensing units, etc.) and route to nearest floor drain, mop sink, etc. Coordinate final location with architect.

3.10 VIBRATION ISOLATION

A. Vibration Isolation: Section 20 05 50.

3.11 TESTING

A. Test heating and cooling piping upon completion of a section or of entire system.
   1. Test hydrostatically to pressure not less than 50 PCT in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case less than 150 PSI.
   2. Repair or replace leaks or defective pipe disclosed by tests.

3. Repeat tests until piping indicates tight.

3.12 CLEANING OF CHILLED AND HEATING WATER SYSTEMS

A. Do not valve in or operate system pumps until after system has been cleaned.

B. At system completion, make temporary connection to domestic water system, and flush system until clear water is visible from drain connection.
   1. Drain system after flushing.

C. At project completion, clean systems:
   1. Thoroughly flush system with a recommended hot solution (160-180 DEGF) of alkaline cleaning chemical to remove oil and grease that may be present.
      a. Thorough flushing includes eliminating air from system.
      b. Drain systems, and rinse completely with clean water.
      c. Measure and record volume of each system for purpose of chemical treatment.
   2. Add water and acid solution, and circulate through systems as recommended by manufacturer to remove rust and scale.
      a. Circulate solution through systems at a minimum velocity of 10 FPS.
      b. Drain systems, and rinse completely with clean water.
         1) Rinse system at a minimum velocity of 10 FPS.
   3. Check drain water for pH level.
   4. If drain water is acidic, neutralize system by thoroughly reflushing with alkaline-type material as indicated above.

D. After cleaning is complete, and just before start-up, clean strainers.

3.13 START-UP

A. After cleaning is complete, and water pH is acceptable to manufacturer of water treatment chemicals, add manufacturer-recommended amount of chemicals to systems.

B. Provide monthly testing for the first six months after start-up to verify that the correct chemical concentrations are present in each system.

END OF SECTION

SECTION 23 21 23
HVAC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for HVAC Pumps, as indicated, in accordance with provisions of Contract Documents.

B. Types Included:
   1. Vertical multistage pumps.
   2. Double suction pumps.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Standards:
   1. Hydraulic Institute Standards: HI1983, 14TH Edition.
   2. Hydraulic Institute Engineering Data Handbook: HI979, First Edition.

1.3 SUBMITTALS

A. Product Data:
   1. Pumps:
      a. Include curves.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Vertical multistage pumps:
   1. Base:
      a. Goulds.
   2. Optional:
      a. Durco.
      b. Peerless Pump.
      c. Grundos.
      d. Taco.

B. Double suction, heating, cooling and condenser water pumps:
   1. Base:
      a. Taco.
   2. Optional:
      a. Bell & Gossett, ITT, Xylem.
      b. Goulds Pumps.
      c. CRI Pumps.
      d. Armstrong Pumps.
      e. Pentair.

C. Flexible pump couplings:
   1. Base:
      a. Dodge Regupol; "Para-flex".
      b. Wood's "Sure-flex".

D. Pumps and drives by same manufacturer.

E. Other manufacturers desiring approval comply with Section 01 25 00.

2.2 MATERIALS

A. 870 kPa1040 kPaVertical Multistage Pumps
   1. Each pump shall be an integral unit consisting of a vertical multistage centrifugal pump and motor.
   2. Pumps shall have wetted metallic parts using passivated type 316L stainless steel. Single external mechanical seal model shall have silicon carbide/silicon carbide surfaces, and stainless steel metallic parts. Elastomers shall be FPM (Viton®).
   3. Pump shall be non-contaminating and designed for the service intended. No oils or grease shall be used during assembly of the volute and impeller.
   4. Pump suction and discharge connections shall have non-threaded, flanged connections that conform to ANSI standards.
   5. All pumps shall be sized such that the impeller required at the given maximum flow and head is midrange of the impellers available in the casing provided. Motor horsepower shall be sized to prevent motor overloading at reduced system head.
   6. Operating point shall not be to the right of the maximum efficiency on the pump curve.
   7. Bearing material shall be recommended and guaranteed by pump manufacturer. Life of anti-friction ball or roller bearings shall be calculated in accordance with ANSI/AFBMA 9, Load Rating and Fatigue Life for Ball Bearings, or ANSI/AFBMA 11, Load Rating and Fatigue Life for Roller Bearings, and guaranteed for a minimum life of 50,000 hours at rated conditions.
   8. Impellers shall be balanced in accordance with International Organization for Standardization (ISO) G6.3.
   9. Motor enclosures shall be TEFC. Motors shall be inverter duty rated, suitable for variable frequency drive (VFD) operation. Motors shall be in accordance with Section 20 05 00.
   10. Pump motor drives: See Section 25 23 00 for variable frequency drives (VFD).

B. Double Suction Pumps
   1. Pumps, heating, cooling and condenser water: Centrifugal, single stage, double suction, horizontal mounted, split case, with electric motor drive.
      a. Capacity: As scheduled.
      b. Deliver required head and GPM at 1750 RPM, with shut-off head not more than 25 PCT over rated head.
      c. Motor coupling: Flexible type.
      d. Mount motor and pump on common base.
   2. Casing: Horizontal split type.
      a. Design casing of cast or ductile iron for 150 PSI static pressure.
      b. Casting faces accurately machined and dowelled for bolting together.
      c. Provide 125 PSI flanges on suction and discharge openings.
      d. Rotating element removable without disturbing pipe connections by removing half casing and bearing caps.
   3. Pump impeller: Bronze or brass, enclosed double suction type, radial flow design balanced both mechanically and hydraulically.
      a. Press impeller upon shaft over key to lock shaft sleeves in place.
      b. Provide axial adjustment by means of shaft sleeve locking nuts.
   4. Pump wearing rings:
      a. Casing: Cast iron with streamlined water guiding surfaces.
      b. Impeller: Bronze.
      c. Provide clearances on wearing rings sufficient to prevent mating parts from touching under static deflection of impeller and shaft.
   5. Pump shaft: High grade carbon steel, machined and accurately ground to size to ensure low working stresses under normal conditions imposed by driver.

a. Protect against corrosion and abrasive action of liquid by means of stainless steel shaft sleeves held in place by locknuts.
b. Make shaft long enough to permit flexible couplings to be disconnected.
c. Design shaft so that, in starting and stopping, it will not pass through critical speed range.
d. Make it rigid enough to meet requirements of wearing rings.

6. Pump bearings: Ball or roller bearings of deep groove or tapered type, sized to withstand axial and radial loads imposed upon pump shaft.
   a. Bearing housings: Cartridge type, designed so that entire rotating element may be removed from pump without disturbing alignment or exposing bearings to contaminants.
   b. Position housings by means of dowel pins in pump casing and securely clamp in place by covers fit on horizontal plane.
7. Pump seals: Mechanical, ceramic on carbon or hardened metal alloys on carbon.
   a. Working pressure: 150 PSI.
8. Pump base: Cast iron or steel, welded construction with intermediate ribs, closure plates and other reinforcing to provide rigid frame.
   a. Provide with raised lip for water drainage and threaded drain tapping.
   b. Provide holes for grouting.
   c. Provide drain pipe to floor drain.
9. Pump couplings, flexible: Dodge Para-Flex.
   a. Taper-Lock bushings keyed to shaft.
   b. 18 GA sheet metal coupling guard.
10. Pump motor drives: See Section 20 05 00.
    a. Variable speed application, totally enclosed fan cooled (TEFC) enclosure for wet environment.

2.3 EXTRA MATERIALS

A. Provide one extra mechanical pump seal with gaskets for each double suction pump.

2.4 VIBRATION ISOLATION

A. Vibration Isolation: Section 20 05 50.

PART 3 - EXECUTION

3.1 GENERAL

A. Install pumps according to manufacturer's recommendations and as specified.

3.2 BASE MOUNTED PUMP INSTALLATION

A. Set floor mounted horizontal pump on concrete base.

B. Level and bolt down.

C. Fill entire base with non-shrinking grout.

D. After pump base grouting is complete, align pump and each driver accurately to provide out of alignment of not over 0.004 IN in both axial and angular planes.
   1. After alignment, pin pump and motor to base with taper pins using minimum of 3 pins each.

E. Connect to piping system as indicated.

3.3 VIBRATION ISOLATION

A. Vibration Isolation: Section 20 05 50.

END OF SECTION

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SECTION 23 22 00
STEAM DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for Steam Distribution System, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. Pressure reducing valves.
2. Safety valves.
3. Steam and steam condensate valves.
4. Steam traps, trap stations.
5. Specialties.
6. Pipe and fittings.
7. Condensate pumps and receiver.

C. Work installed but not furnished:
1. Automatic valves: Furnished in Section 25 50 00.
   a. Provide necessary fittings and reducers.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manual valve standards: Section 20 05 23 (for valves labeled "V-__").

B. Outside Utilities: Section 20 10 10.

C. Piping standards: Section 20 11 00.

1.3 SUBMITTALS

A. Product Data.

B. Contract Closeout Information:
1. Operation and Maintenance Data.
2. Test reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pilot Operated Pressure Reducing Valves:
1. Base:
   a. Spirax Sarco.
2. Optional:
   a. Spence.
   b. Hoffman Specialty.
   c. Armstrong.

B. Steam Safety Valves:
1. Base:
   a. Kunkle.
2. Optional:
   a. Watts.
   b. Consolidated.

C. Steam Traps:
1. Base:
a. Spirax Sarco.
2. Optional:
a. Armstrong International.
b. Bell & Gossett.

D. Electric Condensate Pumps/Receivers:
1. Base:
a. Bell & Gossett.
2. Optional:
a. Hoffman Specialty.
b. Armstrong.
c. Spirax Sarco.
d. Roth.
e. Domestic Pump ITT.

E. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Pressure Reducing Valves:
1. Pressure reducing valves - general:
a. Flow capacity and pressure range: As indicated.
b. Provide wye strainer on inlet side of each valve.
c. Provide noise diffuser to limit rated sound level to 85 dBA at a distance of 3 FT from the valve.
2. Pressure reducing valves (less than 8000 LBS/HR): Spring pilot operated globe type regulator with post guiding and push down to open valve plug action.
a. Cast iron body with screwed or flanged end connections.
b. Stainless steel seats and trim.
c. Body rating: Class 250.
d. Cast iron pilot with stainless steel trim.

B. Safety Valves:
1. Safety valves, steam:
a. Sizes 3 IN and less: Threaded or flanged ends.
1) Basis of design: Kunkle model 6252.
b. For capacities over 3 IN use multiple valves.
c. Valve sizing: Sized for 10 PCT overpressure with a minimum of 5 PSIG overpressure on pressure reducing valve setting.
d. Valves to have test levers.

C. Steam Valves To 100 PSIG:
1. Isolation valves (gate valves), LPS and MPS:
a. 2 IN and smaller: V-2.
b. 2-1/2 IN and larger: V-3.
2. Globe valves, LPS and MPS:
a. 2 IN and smaller: V-7.
b. 2-1/2 IN and larger: V-8.
3. Angle valves, LPS and MPS:
a. 2 IN and smaller: V-17.
b. 2-1/2 IN and larger: V-18.
4. Check valves, vacuum breaker, LPS and MPS (2 IN and smaller): V-23.
5. Check valves, other, LPS and MPS:
a. 1-1/2 IN and smaller: V-25.
b. 2 IN and larger: V-22 or V-28.

D. Steam Valves 100 To 200 PSIG:
1. Isolation valves (gate valves), HPS:
   a. 2 IN and smaller: V-4.
   b. 2-1/2 IN and larger: V-5.
2. Globe valves, HPS:
   a. 2 IN and smaller: V-9.
   b. 2-1/2 IN and larger: V-10.
3. Angle valves, HPS:
   a. 2 IN and smaller: V-19.
   b. 2-1/2 IN and larger: V-20.
4. Check valves, other, HPS:
   a. 2 IN and smaller: V-31.
   b. 2-1/2 IN and larger: V-32.

E. Steam Condensate Return Valves:
1. Isolation valves (ball valves):
   a. 2 IN and smaller: V-13 or V-14.
2. Isolation valves (gate valves):
   a. 2 IN and smaller: V-1 or V-2.
   b. 2-1/2 IN and larger: V-3.
3. Globe valves:
   a. 2 IN and smaller: V-6 or V-7.
   b. 2-1/2 IN and larger: V-8.
4. Angle valves:
   a. 2 IN and smaller: V-17.
   b. 2-1/2 IN and larger: V-18.
5. Plug valves:
   a. 2 IN and smaller: V-36.
   b. 2-1/2 IN and larger: V-37.
6. Pump discharge check valves:
   a. 2 IN and smaller: V-25 or V-26.
   b. 2-1/2 IN and larger: V-28, V-29, or V-30.
7. Other check valves:
   a. 2 IN and smaller: V-25.
   b. 2-1/2 IN and larger: V-28 or V-29.

F. Specialties:
1. Steam traps - general:
   a. Sizes: As indicated, minimum; increase size if required to meet capacity requirements.
   b. Provide dirt pocket and wye strainer full size of trap opening.
   c. Provide shut-off valve and union on each inlet.
   d. Provide check and gate valve in discharge, at each lift leg.
2. Steam traps, low pressure (15 PSIG and less):
3. Equipment traps: Use F & T type rated at 15 PSI working pressure. Each trap shall be sized using 1/2 PSI pressure drop and 2 times scheduled flow rate of equipment. Where two traps are shown on a single piece of equipment (e.g. heat exchanger), each trap shall be sized for 100 PCT redundancy.
4. Where applicable use trap station by Spirax Sarco.

Trap Size	Capacity
3/4 IN	400 LB/HR
1 IN	700 LB/HR
1-1/4 IN	900 LB/HR
1-1/2 IN	1700 LB/HR
2 IN	4000 LB/HR

5. End of main traps: Use inverted bucket type. Trap sizes shall be as indicated on plans. If size is not indicated, the minimum trap size shall be 3/4 IN . The minimum capacities for each size of trap shall be as follows (based on 2 PSI differential):

Trap Size	Orifice Size	Capacity
3/4 IN	3/16 IN	350 LB/HR
3/4 IN	1/4 IN	800 LB/HR
1 IN	3/8 IN	1600 LB/HR
1-1/4 IN	1/2 IN	2600 LB/HR
1-1/2 IN	9/16 IN	4000 LB/HR

6. Steam traps, medium and high pressure (over 15 PSIG):
   a. Equipment traps: Use F & T type.
   b. Equipment traps (16-30 PSIG): Sized using 2 PSI pressure drop and 2 times scheduled flow rate of the equipment.
   c. Equipment traps (over 30 PSIG): Sized using 1/2 of the maximum pressure differential across the trap and 3 times scheduled flow rate of the equipment.
   d. End of main traps: Use bucket type. Trap size: as indicated on plans. If size is not indicated, the minimum trap size shall be 3/4 IN . The minimum capacities for each size of trap shall be as follows (based on 2 PSI differential).
   e. Where applicable use Spirax Sarco STS17, 2 Universal Station.

Trap Size	Capacity
3/4 IN	1150 LB/HR
1 IN	2300 LB/HR
1-1/4 IN	3700 LB/HR
1-1/2 IN	5400 LB/HR
2 IN	10700 LB/HR

7. Bucket Traps:
   a. Straight through pattern to permit maximum headroom under return piping.
   b. Provide check valve on required lift legs.
   c. Basis of Design: Armstrong Series 200 and 800.
   d. Rated for 250 PSIG operating pressure.
8. Float and Thermostatic Traps (F & T):
   a. Basis of Design (15 to 30 PSIG): Armstrong Series B.
   b. Basis of Design (Above 30 PSIG): Armstrong Series A.
9. Steam Traps on Equipment:
   a. Provide traps and cooling legs, 18 IN deep minimum.
   b. Connect trap line to cooling leg 6 IN from bottom.
   c. Provide cap.
   d. Install trap above floor (elevate equipment if necessary).
   e. Where equipment is mounted close to structural floor and it is not possible to elevate equipment, install trap below floor; provide sleeve in floor.
10. Flash tank: Centrifugal design with stainless steel striking plate at point of inlet impingement with surfaces and baffles slanting for quick drainage and no pockets for condensate accumulation.
    a. Inlets and outlets as indicated.
    b. Basis of design: Pennsylvania Separator Co.
11. Strainers: See Section 20 05 19.
12. Supports, sleeves and seals: See Section 20 05 29.
13. Flashings: See Section 20 05 00.

14. Thermometers: See Section 20 05 19.
15. Pressure gauges: See Section 20 05 19.

G. Pipe and Fittings:
1. Steam and steam vent piping: Black steel (Schedule 80), seamless piping.
   a. 2-1/2 IN and larger: Use welded joints, with steel butt welding fittings.
   b. 2 IN and smaller: Use threaded joints, with cast iron threaded fittings, or welded joints with socket welding (3000 PSI) fittings.
2. Steam condensate and pumped condensate piping above grade: Black steel (Schedule-80), seamless piping.
   a. 2-1/2 IN and larger: Use welded joints, with butt welding fittings.
   b. 2 IN and smaller: Use threaded joints, with cast iron threaded fittings, or welded joints with socket welding (3000 PSI) fittings.
3. Relief vent pipe and fittings: Black steel (Schedule 40), seamless piping.
4. Steam and steam condensate fittings:
   a. Weld-o-let or thread-o-let type fittings are optional for branch connections except on pump suction lines.
   b. Weld-o-let or thread-o-let type fittings are optional for branch connections provided main is one size larger than takeoff.
   c. Unions 2 IN and smaller: Ground joint, malleable iron, pattern, 175 PSI SWP type.

H. Electric Condensate Pumps/Receiver:
1. Condensate pumps/receiver, above ground.
   a. Duplex, factory assembled, with pumps, receiver, and controls for above floor mounting.
   b. Capacity: As scheduled.
   c. Pump: Vertical submerged centrifugal or turbine type suitable for operation with 210 DEGF condensate.
      1) Bronze impeller, renewable liners and stainless steel shafts.
      2) Flanged mounted on receiver and close coupled to vertical motor.
   d. Motor: See Section 20 05 00.
      1) Non-overloading at working pressure up to design pressure.
      2) Provide magnetic starters for 3-phase motors.
   e. Float switches: Heavy duty 2-pole with seamless copper float and stainless steel rod.
   f. Receiver: Cast iron, with inlet, vent and overflow connections.
   g. Controls: Contained in a unit mounted NEMA II control cabinet with hinged door.
      1) Two combination magnetic starters with circuit breakers and cover interlock.
      2) Manual sequence control switches.
      3) Manual select lead pump.
      4) Each pump control circuit to be independent of the other.
      5) Alternator: Provide simultaneous operation under peak load conditions; and operate second pump automatically, should active pump or its controls fail.
      6) Provide control circuit transformer for each circuit.
      7) The pump controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls. See Section 25 50 00 and Section 25 51 00.
   h. Provide inlet strainer with vertical self-cleaning bronze screen and large dirt pocket mounted on receiver.

PART 3 - EXECUTION

3.1 PIPING - GENERAL

A. Install in accordance with Section 20 11 00 and Section 20 05 00.

B. Provide drain piping from safety valves and valves that have test levers to floor drain.

3.2 STRAINERS

A. Provide full line size wye strainers ahead of steam control valves (motor operated), steam traps, regulating valves, pumps, and where indicated.
   1. See Piping Specialties: Section 20 05 19.

3.3 TESTING

A. Allow no piping to be insulated, concealed, or furred-in until testing is completed.

B. Upon completion of a section or of entire piping systems, hydrostatically test to pressure not less than 50 PCT in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case less than 150 PSI .
   1. Remove traps during tests and valve off or bypass coils, pumps and equipment, etc.

C. Repair leaks and replace defective pipe disclosed by tests and repeat tests until piping is air tight.

3.4 CLEANING

A. Cleaning of steam supply piping: Before steam supply system is placed in service either for temporary or permanent use, clean and flush as follows:
   1. For temporary use where additional piping will be added to system as construction proceeds, flush piping by "blowing down" with steam.
   2. At completion of project after piping is complete, flush piping by "blowing down" with steam until visual inspection indicates system cleaned. During "blow down" period: Waste condensate to sewer.
   3. After "blow down" period is complete, thoroughly clean strainers and traps.

B. Cleaning of condensate return piping: Before steam condensate return system is placed in service either for temporary or permanent use, clean and flush as follows:
   1. For temporary use where additional piping will be added to system as construction proceeds, and before strainers, traps, equipment, etc., are installed, flush piping by "blowing down" with steam.
   2. At completion of project after piping is complete, and steam supply mains are "Blown Down", flush steam condensate return piping by "blowing down" with steam until visual inspection indicates system cleaned.
   3. Prior to "blowing down" system remove strainers and traps from system and bypass equipment connected to system.
   4. During "blow down" period: Waste condensate to sewer or atmosphere outside building.
   5. After "blow down" period, clean strainers and traps and reinstall in piping system. Reconnect equipment previously bypassed.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for Refrigerant Piping System, as indicated, in accordance with provisions of Contract Documents.

B. Systems Include:
1. Refrigeration piping.
2. Refrigeration valves.
3. Refrigeration specialties.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Piping standards: See Section 20 11 00.

B. Valve standards: See Section 20 05 23.

1.3 SUBMITTALS

A. Contract Closeout Information:
1. Test reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refrigerant piping specialties:
1. Base:
a. Sporlan Valve.

B. Expansion valves:
1. Base:
a. Sporlan Valve.
b. Alcoa Building Products.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Pipe and Fittings
1. Refrigerant piping: Copper, dehydrated, with high-temperature soldered joints and wrought copper (400 PSIG) fittings.
a. For above ground use: ACR.
2. For field assembled units, size refrigeration lines in accordance with manufacturer's published tables using pressure or temperature drops as follows:
a. Suction lines: 2 DEGF.
b. Liquid lines: 1 DEGF or 2 PSI.
c. Hot gas lines: 1 DEGF or 3.6 PSI.
d. Size discharge and hot gas risers for positive oil return to compressors.
3. Hangers: See Section 20 05 29.

B. Refrigerant Piping Specialties
1. Moisture indicator: indicate presence of moisture in system by change of color.
a. Install adjacent to filter.

b. In bypass line use Sporlan SA-12S.

2. Strainers: Design to permit removing screen without removing strainer from piping system.
   a. Provide with screens of not larger than 80 mesh.
   b. Provide strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.
3. Oil traps:
   a. Provide in lines as required.

C. Valves
1. Valves: Bronze.
   a. In lines 2 IN and smaller: Solder ends.
   b. In lines 3 IN and over: Four bolt union ends.
2. Shut off valves: Packed type with gas tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.
   a. Wheel, globe, angle or "T" handle.
3. Check valves:
   a. In liquid lines 5/8 IN and smaller: Lift check type.
   b. In lines 3/4 - 2 IN: Swing check type.
   c. In lines 3 IN and over: Wafer type swing check with bronze disc.
4. Expansion valves: Sized by manufacturer for refrigerant used.
   a. Provide one in each circuit with liquid distributor connection immediately after.
5. Vent and test valves: Angle cap type with seal and outlet caps.

PART 3 - EXECUTION

3.1 REFRIGERANT PIPING ASSEMBLY

A. Install in accordance with Section 20 11 00.

B. Install trapping risers to assist oil flow back to compressor.

C. Thoroughly clean piping of dirt and grease on inside with a suitable cleaning solution just before soldering.

D. Polish end of tube and inside of fitting.

E. Purge refrigerant piping of air while connections of refrigerant piping are being made.
1. Shut off valves.
2. Connect tank of dry nitrogen to line on back side of valve.
3. Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.

3.2 TESTING

A. Do not insulate or conceal piping until testing is completed.

B. Test refrigerant piping to hold pressure of twice normal working pressure for period of 72 hours before refrigerant is added.

C. Testing pressure shall not exceed maximum rating of weakest component of system.
1. Place an initial charge of Freon in system for detection purposes.
2. Use dry nitrogen gas for pressure testing.
3. Low side to be valved off and tested to 200 PSI.

D. Check joints with an electronic leak detector.

E. Cut out joints found to be leaky and replace with new material.

3.3 CLEANING

A. After complete system is tested, disconnect suction and discharge lines from compressor for cleanup.

B. Valve or blank off system into three separate systems for purpose of cleanup.
   1. Suction side including cooling coils.
   2. Discharge side including air cooled condenser.
   3. Hot gas reheat side including heating DX coils.

C. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant or any foreign matter shall be considered contaminated systems.

D. Restore contaminated system(s) to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging using current refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Owner.

E. Notify Engineer for a visual inspection of both cleaning process and completely cleaned system.

3.4 EVACUATION AND DRYING

A. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean Freon to approximately 50 PSI of gas pressure.

B. Evacuate to 100 micron Hg and hold for 48 hours.
   1. Use laboratory type vacuum pump capable of holding absolute pressure of 50 micron Hg.

C. Admit another drying charge of Freon and allow 4 to 6 hours to absorb moisture and install dryer cores.

D. Use second evacuation to remove Freon and moisture.

E. After second evacuation, charge system with Freon.

F. Add refrigerant to system as required after final evacuation.

END OF SECTION

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SECTION 23 31 13
AIR DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Air Distribution System, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. High and low pressure ductwork, fittings and accessories.
2. Fume hood exhaust ductwork.
3. Dampers.
4. Fire and smoke dampers.
5. Diffusers, registers and grilles.
6. Acoustical louvers.
7. Sound attenuators.
8. Duct access doors.
9. Control dampers less actuators.
   a. Actuators for control dampers: See Section 25 50 00.

C. Work installed but not furnished:
1. Automatic dampers: Section 25 50 00.

D. Definitions:
1. Low and high pressure ductwork: See Article 2.2 of this section.
2. Gage:
   a. Steel sheet and wire: U S Standard Gage.
   b. Aluminum sheet: Browne & Sharpe Gage.
   c. Steel wire: Washburn and Moen Gage.
3. Concealed insulated surfaces: Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts and above suspended ceilings.
4. Exposed insulated surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

E. Location of diffusers, registers and grilles are indicated on Architectural reflected ceiling plans.

F. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Design and installation standards:
1. ASHRAE Handbook - HVAC Systems and Equipment: Chapter on duct construction.
2. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.
3. ADC Test Code FD 72-R1: Flexible Air Duct Test Code.
4. AMCA Standard 210: Test Code for Air Moving Devices.
5. ASHRAE Standard 70: Method of Testing for Rating the air flow performance of outlets and inlets.
6. NFPA-90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
7. SMACNA HVAC Duct Construction Standard - Metal and Flexible.
8. SMACNA Duct Cleanliness for New Construction.
9. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.

11. ASTM A109: Standard Specification for Steel, Strip Carbon (0.25 Maximum Percent), Cold-Rolled.
12. ASTM B23: Standard Specification for White Metal Bearing Alloys (Known Commercially as Babbit Metal).
13. ASTM E96: Standard Test Methods for Water Vapor Transmission of Materials.
14. UL 181A: Closure Systems for Use with Rigid Air Ducts.
15. UL 181B: Closure Systems for Use with Flexible Air Ducts and Air Connectors.

B. Fire and smoke rating test standards: ASTM-E84, NFPA-255 and ANSI/UL-723.

C. Duct sizes indicated are internal sizes.

D. Related Sections:
1. Special Mechanical Requirements: Section 20 05 00.
2. Pipe, Duct and Equipment Insulation: Section 20 07 00.

1.3 SUBMITTALS

A. Shop Drawings:
1. Ductwork layout at 1/4 IN to 1 FT scale.
   a. Layout drawings to include sign-off from balancing contractor indicating the contractor has reviewed the documents to ensure volume damper installation is in compliance with the requirements of this section.
   b. Shop drawings may not be copied, traced, or any other reproduced version of the construction documents.
   c. Shop drawings should show progress from coordination with other trades, ductwork elevations, fittings, joints, sheet metal gauges, and any other pertinent information related to the layout, installation, or construction of the ductwork.

B. Product Data:
1. Ductwork and fittings, high pressure.
2. Dampers, nonrated.
3. Dampers, fire.
4. Dampers, smoke.
5. Dampers, combination fire and smoke.
6. Diffusers, registers and grilles.
7. Sound Attenuating Louvers.
8. Sound Attenuators.
9. Control dampers (less actuators).

C. Contract Closeout Information:
1. Operation and Maintenance Data for applicable devices such as: fire and smoke dampers, and control dampers.
2. Test reports.

D. LEED Information:
1. EQ 4.1, Low-Emitting Materials, Adhesives and Sealants: Manufacturers' product data for construction adhesives and sealants including VOC content for products used in this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Flat oval and round spiral ductwork, high pressure:
1. Base:
   a. United McGill Airflow Corporation.
2. Optional:
   a. Semco Incorporated.

b. Sheet Metal Connectors, Inc.
c. Eastern Sheet Metal, Inc.
d. Spiral Pipe of Texas.

B. Factory fabricated duct connection systems:
1. Base:
a. Ductmate Industries.
2. Optional:
a. Nexus.
b. Ward Industries, Inc.

C. Sealants, mastics and adhesives:
1. Base:
a. Hardcast.
2. Optional:
a. United McGill Airflow Corporation.
b. Foster (Division of HB Fuller).

D. Turning vanes:
1. Base:
a. Aerodyne Controls.
2. Optional:
a. Airsan.
b. Tuttle & Bailey.
c. Titus.
d. VentProducts.

E. Flexible fan connections:
1. Base:
a. Ventfabrics.
2. Optional:
a. Duro-Dyne.
b. Elgin.

F. Flexible duct, preinsulated:
1. Base:
a. Atco.
2. Optional:
a. Flexible Technologies, Thermaflex.
b. Hart and Cooley.
c. Flexmaster.

G. Access doors, low pressure:
1. Base:
a. Ruskin Manufacturing.
2. Optional:
a. Air Balance.
b. Nailor-Hart Industries, Inc.
c. Ventfabrics.
d. CESCO products.
e. Safe-Air of Illinois.

H. Access doors, low and high pressure:
1. Base:
a. Ductmate.
2. Optional:
a. Ward Industries.
b. United McGill Airflow Corporation.

I. Dampers (manual, backdraft, and control):
   1. Base:
      a. Ruskin Manufacturing.
   2. Optional:
      a. Arrow Louvers and Dampers, Inc.
      b. American Warming & Ventilating.
      c. Air Balance.
      d. Cesco Products.
      e. Greenheck.

J. Fire and smoke dampers:
   1. Base:
      a. Ruskin Manufacturing.
   2. Optional:
      a. Greenheck.
      b. Pottorff.

K. Diffusers, registers and grilles (except laminar flow in ceiling systems and radial throw diffusers):
   1. Base:
      a. Price.
   2. Optional:
      a. Anemostat Air Products.
      b. Carnes.
      c. Tuttle & Bailey.
      d. Krueger.
      e. Titus.

L. Acoustical Louvers:
   1. Base:
      a. Price.
   2. Optional:
      a. Arrow.
      b. Greenheck.
      c. Ruskin Manufacturing.

M. Sound Attenuators:
   1. Base:
      a. Vibro-Acoustics.
   2. Optional:
      a. AeroSonics.
      b. Ruskin Sound Control.
      c. Semco Incorporated.
      d. McGill AirSilence, LLC.
      e. Industrial Acoustics.
      f. Commercial Acoustics.

N. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Sheet metal:
   1. Galvanized steel (G90): ASTM-A653/A653M.
   2. Black steel: ASTM-A109.
   3. Stainless steel: ASTM-A167.

B. Duct sealer: NFPA rating of "Non-Combustible".
   1. Flame spread rating: 25 or lower, in dry condition.

2. Smoke developed rating: 50 or lower, in dry condition.
3. Resistant to water and water vapors.
4. Pressure rupture rating: 16 IN WG , minimum.
5. Durkee-Atwood Permatite Class I Duct Sealer; Hardcast Iron Grip 601 and Duct Seal 321; or United McGill Sheet Metal Uni-Mastic 181 Duct Sealer and United Duct Sealer.
6. Duct sealer shall have a VOC content no greater than 250 g/L.

C. Solder: ASTM-B23, Grade-50B.

D. Duct sealing tape: NFPA rating of "Non-Combustible".
1. Flame spread rating: 25 or lower, in dry condition.
2. Smoke developed rating: 50 or lower, in dry condition.
3. Adhesive: Specifically compounded for maximum adhesion to galvanized and stainless steel.
4. Listings/Labels: UL 181A or UL 181B.

E. RTV foam: UL listed room temperature vulcanized silicone rubber foam.

2.3 DUCTWORK

A. Ductwork - general:
1. Maintain full areas and suitable shapes at every point.
2. Shapes may be changed to fit unusual space conditions.
   a. Cross sectional area to be maintained.
   b. Modifications increasing system pressure drop require Architect approval.
   c. Modifications increasing aspect ratio beyond 5:1require architect approval.
3. Provide necessary transitions and offsets to complete systems.
4. All systems shall be constructed of G90 galvanized steel, except where indicated otherwise.

B. Ductwork, low pressure, sheet metal:
1. Construct in accordance with SMACNA HVAC Duct Construction Standard per appropriate SMACNA table.
   a. Ductwork for systems operating between 2 IN WG and 3 IN WG static pressure, positive or negative:
      1) Rectangular duct.
      2) Round spiral seam duct.
   b. Ductwork systems operating under 2 IN WG positive or negative:
      1) Rectangular duct.
      2) Round duct: spiral or longitudinal seam.
2. Low pressure ductwork includes but is not limited to:
   a. Supply air ductwork on outlet side of single and dual duct air terminal units.
   b. Return, relief air, and outside air ductwork.
   c. General and Laboratory Exhaust air ductwork from air inlets to air terminal units.
   d. General and Laboratory Exhaust air for other exhaust systems operating less than 3 IN WG static pressure, positive or negative.
   e. Exhaust ductwork not identified as Fume Hood Ductwork operating less than 3 IN WG static pressure.
3. Transverse joints, rectangular:
   a. Ducts with longest side 36 IN and longer:
      1) Use factory fabricated flanged duct connection systems (e.g. Ductmate 35/25 slide on systems).
      2) Non-proprietary SMACNA defined T-22 or T-24 flanged connections
      3) Seal transverse flanged duct connections with pressure sensitive, high density, closed cell, neoprene or polyurethane tape gasket.
   b. Ducts with longest side shorter than 35 IN:
      1) Flanged duct connection systems as defined above are optional.

2) Refer to SMACNA HVAC Duct Construction Standard for proper duct construction.

4. Longitudinal seam: Use Pittsburgh lock seam only.
5. Seal low pressure ducts to Seal Class A requirements.
6. Runouts to diffusers, register and grilles: Flexible ducts may be used.
   a. Exception: Flexible ducts may not pass through smoke or fire rated walls, floors or ceilings.
   b. Maximum flexible duct length: 3 FT.
   c. Minimum turning radius:
      1) As recommended by manufacturer.
      2) Do not kink, bend or restrict free area of duct as to generate additional pressure drop or noise. Use UL listed "FlexRite" radius forming brace designed to form flexible duct into highly efficient 90 degree elbow.

C. Ductwork located outside, exposed to weather:
   1. Construct using flanged duct connection systems.
   2. Seal flanged ends with pressure sensitive, high density, closed cell, neoprene or polyurethane tape gasket.
   3. Use continuous cleat seals on top joints of ducts.

D. Ductwork, high pressure:
   1. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
      a. Rectangular duct: Table 1-8, 6 IN WG static pressure, positive or negative.
      b. Round duct: 10 IN WG static pressure.
      c. Flat oval duct: Table 3-4, 10 IN WG static pressure.
   2. Transverse joints, rectangular:
      a. Use factory fabricated flanged duct connection systems (e.g. Ductmate 35/25 slide on systems).
      b. Non-proprietary SMACNA defined T-22 or T-24 flanged connections
      c. Seal transverse flanged duct connections with pressure sensitive, high density, closed cell, neoprene or polyurethane tape gasket.
   3. Longitudinal seam: Pittsburgh lock seam.
   4. High pressure ductwork includes:
      a. Supply air ductwork from air handling unit discharge to connection with single and dual duct air terminal units.
      b. General and Laboratory Exhaust air ductwork between suction side of exhaust fan and air terminal units (e.g. isolation exhaust system).
      c. General and Laboratory Exhaust air or return air ductwork for other exhaust systems operating over 3 IN WG static pressure.
   5. Runouts to air terminal units: Straight rigid or flexible ductwork.
      a. Provide rigid ductwork on units located in rated corridors or corridors requiring smoke tight construction, where ducts pass through smoke or fire rated walls, floors or ceilings, and connections to air terminal units for exhaust or return systems.
      b. Maximum flexible duct length: 1 FT.
   6. Seal high pressure duct to seal Class A requirements.

E. Duct hangers and supports: In accordance with following:
   1. High and low pressure ductwork (sheet metal): SMACNA HVAC Duct Construction Standard.

F. Duct fittings and joints on low pressure systems:
   1. Radius elbows without vanes: Radius ratio (R/W) of 1.5 and greater.
   2. Radius elbows with vanes: Radius ratio (R/W) less than 1.5; use where space limitations occur.
      a. R/W = 0.75 to 1.0: Provide 3 vanes in elbow.
      b. R/W = 1.0 to 1.25: Provide 2 vanes in elbow.
      c. R/W = 1.25 to 1.5: Provide 1 vane in elbow.

d. Provide vane spacing per SMACNA HVAC Duct Construction Standards.

3. Where square elbows are indicated or required, provide with turning vanes.
4. Connections to diffusers, grilles and registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
5. Branch connections:
   a. Round: Factory built short cone or bellmouth type. Air scoops are not acceptable.
   b. Rectangular: 45 degree entry type or radius elbow.
6. Provide necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or indicated on drawings.
7. Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.

G. Duct fittings and joints on high pressure systems:
1. Elbows 3 to 8 IN diameter: Die stamped, for minimum air friction loss, with continuous corrosion resistance welds.
2. Elbows over 8 IN diameter: Welded segment type, not less than 5 pieces for 90 degree elbows, and not less than 3 pieces for 45 degree elbows, using corrosion resistant welds.
3. Tees: "Low loss, short cone type", unless specifically detailed otherwise for space limitations.
4. "Y's" 45 degree type. 60 degree type may be used if space conditions dictate.
5. Install "Y's" as indicated.
6. Where tees are indicated, "Y's" may be substituted if space is available.
7. "Y's": Straight sided type (no cone).
8. Takeoffs from air handling unit plenums: Standard Bellmouth fittings.
   a. Construct in accordance with SMACNA HVAC Duct Construction Standards.
9. "Y" takeoffs from horizontal ceiling mounted ducts to serve boxes: May be straight sided, shop fabricated type by accurately cutting and welding "Y's" into spiral ducts without use of fittings.

H. Turning vanes: For square elbows.
1. Velocities up to 2500 FPM: Single vane, runner Type 2, with 3/4 IN trailing edge, 2 IN vane radius and 1.5 IN vane spacing, minimum 24 GA.
   a. For widths over 36 IN install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
2. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45 degrees angle to give optimum turning.
3. Radius elbows without vanes: Radius ratio (R/W) of 1.5 and greater.
4. Radius elbows with vanes: Radius ratio (R/W) less than 1.5; use where space limitations occur.
   a. R/W = 0.75 to 1.0: Provide 3 vanes in elbow.
   b. R/W = 1.0 to 1.25: Provide 2 vanes in elbow.
   c. R/W = 1.25 to 1.5: Provide 1 vane in elbow.
   d. Provide vane spacing per SMACNA HVAC Duct Construction Standards.
5. Where square elbows are indicated or required, provide with turning vanes.

I. Partitions and blank-off plates:
1. Where used as part of an air handling unit, construct of 14 gauge sheet metal with 1-1/2 IN standing seams.
2. Partitions 8 FT long or less: Provide additional bracing of 1-1/2 x 1/4 IN angles spaced 2 FT on center.
3. Partitions over 8 FT long: Provide additional bracing of 2 x 1/4 IN angles spaced 2 FT on center.

J. Flexible fan connections:
1. Material: Neoprene double coated closely woven glass fabric flexible connections.
2. Fasten fabric to sheet metal duct work and to fan collar extension with 3/16 IN rivets spaced not more than 5 IN on center.

3. Locate in inlet and outlet of fans, as close to fan as possible.
4. Provide at ducts crossing building expansion joints and as indicated on drawings.
5. Connections shall not be under tension.
6. Provide minimum separation distance of 1 IN across the connection.

K. Flexible ducts, preinsulated:
1. Low pressure construction:
   a. Liner: Steel wire helix encapsulated with chlorinated polyethylene (CPE) film.
   b. Insulation: 1 IN x 3/4 LB/CF fiberglass insulation, minimum resistance of R-4.2.
   c. Jacket:
      1) Bi-directional metalized polyester.
      2) Permeability: Not to exceed 0.05 perms when tested in accordance with ASTM E96 Procedure A.
   d. As applicable, all flexible products or assemblies to meet local or state code requirements.
2. High pressure construction:
   a. Liner: Heavy gauge corrugated aluminum with watertight continuous lock seams.
   b. Insulation: 1 IN x 3/4 LB/CF fiberglass insulation, minimum resistance of R-4.2.
   c. Jacket:
      1) Bi-directional metalized polyester.
      2) Permeability: Not to exceed 0.05 perms when tested in accordance with ASTM E96 Procedure A.
      3) Flex duct must also meet any other local or state requirements for flexible duct construction and performance.
3. Rated working pressure:
   a. Low pressure duct: Positive 4 IN WG minimum; negative 1 IN WG minimum, for return or exhaust air connections.
   b. High pressure duct: Positive 8 IN WG minimum; negative 8 IN WG minimum for return or exhaust air connections
4. Fire resistant, self extinguishing, UL-181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. Thermal conductance(C): 0.23 BTU/ h-FT2-F .
6. Low pressure connections:
   a. Secure duct to collar or sleeve with screws, or metal or nylon clamps or bands.
   b. Seal connection with two wraps of duct tape.
7. High pressure connections:
   a. Secure duct to collar or sleeve with duct sealer and 1/2 IN aluminum or galvanized steel bands or clamps.
   b. Secure insulation jacket with two wraps of duct tape.
8. Turn radius: Not less than R/D equal to 1.0. Use UL listed “FlexRight” radius forming brace designed to form flexible duct into highly efficient 90 degree elbow.
9. Provide flexible duct supports in accordance with SMACNA HVAC Duct Construction Standards.
10. As applicable, all products or assemblies to meet local or state code requirements.

L. Access doors:
1. Provide at fire dampers, smoke dampers, fire and smoke dampers, duct mounted automatic dampers, duct mounted coils (except air terminal unit reheat coils) and at other locations indicated on drawings. Access doors shall be positioned to permit easy visual inspection and to allow maintenance and resetting of the device served. Increase duct dimensions at devices when necessary to accommodate required access. Wherever possible, access doors shall be installed above accessible lay-in ceilings. Where access doors are installed above gypboard ceilings or within shafts, provide access panels per Section 20 05 00.
2. Low and high pressure ductwork:

a. Construction: Access doors shall be removable, double wall construction with 1 IN thick fiberglass insulation, closed cell neoprene gasket and attachment bolts, to provide an air tight seal up to static pressures of 20 IN WG.
b. Sizes shall be as follows:
   1) For ducts 18 IN and under, the minimum door size shall be 10 IN X 6 IN.
   2) For ducts 19 IN to 24 IN, the minimum door size shall be 16 IN X 12 IN.
   3) For ducts over 24 IN, the minimum door size shall be 24 IN X 18 IN.
c. To install doors in round ducts or rounded side of flat oval duct, provide duct boot.

2.4 LABORATORY AND FUME HOOD EXHAUST DUCTWORK

A. Laboratory and Fume Hood Exhaust (LE and FHE) ductwork:
1. Provide where shown on drawings.
2. Classified as high velocity and high pressure.
3. Ducts and plenums fabricated from standard gauges, suitable for velocity and pressure of system and as appropriate for welding.
4. Construction material for ductwork, fittings and accessories:
   a. 316 stainless steel.
   b. Duct and fittings shall be fully butt-welded.
      1) Rectangular transverse welded flange type T-21 as shown in figure 2-1 of the SMACNA Manual "HVAC Duct Construction Standards."
   c. Longitudinal seams shall be continuously butt-welded construction. Install with seams at top of duct.
      1) Round butt-weld type RL-4 as shown in figure 3-2 of the SMACNA Manual "HVAC Duct Construction Standards."
   d. Round spiral wound ductwork is not acceptable.
5. Connection to laboratory and fume hood exhaust valves shall be:
   a. Van Stone flange connection with expanded PFA gaskets. Factory provided drawband clamps specifically for air valve use are optional.
   b. Under no circumstance will attachment to laboratory and fume hood exhaust air valves be allowed which penetrate the valve body, either with screw or other fastening methods.
6. Transverse joint connection to dissimilar materials:
   a. Round companion flange type RT-2 as shown in figure 3-1 of the SMACNA Manual "HVAC Duct Construction Standards." Rectangle companion flange type T-22 as shown in figure 2-1 of the SMACNA Manual "HVAC Duct Construction Standards."
7. Bolts, screws and rivets:
   a. Exposed in contaminated fume hood or equipment exhaust air stream: 316 stainless steel.
   b. Not exposed to air stream: Zinc plated stain- less steel, machine hex head type with machine hex nuts.
8. Sleeves:
   a. 24 gauge galvanized spiral duct or 18 gauge black steel.

2.5 DAMPERS

A. Dampers - general:
1. Sizes and types: As indicated.
2. Locate as indicated.
3. Factory built and assembled dampers.

B. Dampers, manual (rectangle and square):
1. Opposed blade type, fitted with shank bolts, marked for direction (open/closed).
2. Provide locking hand quadrant, with 2 IN standoff bracket.
3. Construction:
   a. Greater than 36 x 12 IN :
      1) Frame: 16 gauge galvanized steel formed into structural shape.

2) Blades: 16 gauge galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.
3) Axles: Continuous, steel 1/2 IN hex.
4) Basis of design: Ruskin MD35.

b. 36 x 12 IN and less:
1) Frame: 22 gauge galvanized steel, flat or angle.
2) Blades: 22 gauge galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.
3) Axle: Continuous, steel 3/8 IN hex.
4) System pressure and velocity rating: 2.5 IN WG and 1500 fpm .
5) Basis of design: Ruskin MD25 or MD15.

C. Damper, manual (round):
1. Butterfly type with circular blade mounted to shaft.
2. Frame: Minimum 20 gauge galvanized steel 7 IN segment duct.
3. Blade: Minimum 20 gauge galvanized steel.
4. Shaft: Continuous, Steel 3/8 IN hex.
5. System pressure and velocity rating: 2.5 IN water gauge and 1500 fpm.
6. Hand quadrant: Locking type with 2 IN standoff bracket.
7. Bearings: Self-lubricating nylon or stainless steel sleeve.
8. Basis of design: Ruskin MDRS25.

D. Dampers, control:
1. Frame: Hat channel construction; 16 gauge galvanized steel, 16 gauge stainless steel or extruded aluminum.
2. Blades: Two layers of 22 gauge galvanized steel mechanical joined sheets or extruded aluminum, airfoil shaped, 6 IN wide.
3. Seals: Extruded vinyl blade edge seals and flexible metal compressible jamb seals.
4. Bearings:
a. Aluminum frame construction: Synthetic bearings.
b. Galvanized or stainless steel construction: Stainless steel sleeve or ball bearing.
5. Temperature rating: -40 to 200 °F .
6. Pressure and velocity rating: 4 IN WG pressure differential at 2000 FPM .
7. Leakage rating: AMCA Class IA (3 CFM/SF at 1 IN WG).
8. Blade arrangement: All control dampers shall be opposed blade, except outside air and return air control dampers shall be parallel blade and shall be arranged to promote mixing.
9. Actuators: See Section 25 50 00.
10. Example:
a. Aluminum frame construction: Ruskin CD50.
b. Galvanized frame construction: Ruskin CD60.

2.6 COMBINATION FIRE-SMOKE DAMPERS

A. Fire-smoke dampers, combination - general:
1. UL classified as a Leakage Rated damper under UL555S, latest edition, bearing a UL label attesting to same.
2. UL555 fire rating: 1.5 Hour.
3. Suitable for velocity and pressure of system.
4. Compressible metal jamb seals.
5. Operator installed per UL requirements, in accessible location and visible for inspection.
6. Provide dampers and actuators as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators as a rated assembly.
7. Frame: 16 GA galvanized steel, minimum.
8. Loss through wide open damper:
9. Loss through wide open damper based on AMCA Test Figure 5.3:
a. 12 IN x 12 IN duct size: Not more than 1.25 IN WG at 3000 FPM face velocity.

b. 24 IN x 24 IN duct size: Not more than 0.45 IN WG at 3000 FPM face velocity.
c. 36 IN x 36 IN duct size: Not more than 0.3 IN WG at 3000 FPM face velocity.

10. Provide factory supplied caulked sleeve.

B. Fire-smoke dampers, combination, low pressure:
1. Parallel blade type with blades hinged together for operation in unison and bearings arranged for automatic operation.
2. May be used in lieu of separate fire and smoke dampers.
3. UL555S Leakage Rating: Class I (4 CFM/ SF at 1 IN WG).
a. Ruskin Model FSD37.
4. Fusible link: 165 degF melting point.

C. Fire-smoke damper, combination, high pressure:
1. Parallel blade type.
2. May be used in lieu of separate fire and smoke dampers.
3. UL555S Leakage Rating: Class I (8 CFM/ SF at 4 IN WG).
a. Ruskin Model FSD60 .
4. Fusible link: 165 degF melting point.

D. Actuators, fire-smoke damper: Electric type, factory installed.
1. Two-position.
2. 120 VAC.
3. Spring return fail closed.
4. UL listed at 250 degF.

2.7 DIFFUSERS, REGISTERS AND GRILLES

A. Diffusers, ceiling:
1. Square type.
2. Size, type and manufacturer: As scheduled.
3. Finish of steel units: Factory applied, baked or electrocoated enamel; color as selected by Architect or as indicated.
4. Finish of aluminum units: Satin anodized.
5. Provide sponge rubber gasket for ceiling diffusers.
6. Provide necessary screws, duct collars, transitions and air pattern deflectors.
7. Provide opposed blade dampers where indicated.

B. Air grilles and registers:
1. Size, type and manufacturer: As scheduled.
2. Finish of steel units: Factory applied, baked or electrocoated enamel; color as selected by Architect or as indicated.
3. Finish of aluminum units: Satin anodized.
4. Provide sponge rubber gasket for ceiling and wall units.
5. Provide necessary screws, duct collars and transitions.
6. Provide opposed blade dampers in registers where indicated.

2.8 ACOUSTICAL LOUVERS

A. Acoustical louvers:
1. Construction: Heavy gauge formed aluminum frames, sight proof heavy gauge formed 0.080 IN nominal thickness, positioned at 45 degree blades. Mechanically fastened.
2. Acoustical insulation: Fiberglass insulation.
3. Frame depth: As indicated.
4. Maximum individual section size shall be 60 IN wide by 120 IN high. Larger sizes shall require field assembly of smaller sections.
5. Size and performance: As indicated.
6. Finish: Mill.

2.9 SOUND ATTENUATORS

A. Sound Attenuators:
   1. Prefabricated, straight through design.
   2. Airflow pressure drop and noise reduction (NR) values as indicated on drawings.
   3. Size and shape as indicated on drawings.
   4. Outer casing: 22 gauge, minimum, galvanized steel.
   5. Interior partitions or splitters: 24 gauge, minimum, perforated galvanized steel.
   6. Aluminum construction: At least 50 % thicker than steel specified.
   7. Use straight through air passages.
   8. Use airtight construction.
      a. Make unit leak proof when subjected to differential air pressure of 8 IN WG between outside and inside.
      b. Weld lock joints or seams or fill with mastic.

B. Sound attenuators, noise reduction (NR) rating:
   1. Tests made in such manner as to eliminate end reflections, beaming or directivity, flanking, standing waves, and room absorptions.
   2. Test method may be either "in-duct with anechoic termination" or "reverberant rooms with tunnel between".
   3. Size of units tested: Not smaller than 24 IN x 24 IN rectangular or 24 IN round outside, with full size connections.
   4. Submit corroborative report of tests made in nationally recognized, qualified, independent testing laboratory approved by AMCA for airflow determinations.

C. Sound attenuators, airflow pressure drop rating:
   1. Do not exceed pressure drop at specified airflow(s).
   2. Base rating on results of tests made in manner to provide reliable data.
   3. Basic setup: Standard code method as adopted by AMCA for testing fans.

D. Sound attenuators, acoustical fill:
   1. Inert, vermin and moisture proof, inorganic glass or mineral fiber.
   2. Pack behind partitions or splitters under not less than 5 % compression to provide "spring" and avoid settling.
   3. Fill containment: totally encapsulated and sealed with a polymer film. Separate fill material from perforated baffle by a non-combustible, erosion resistant, acoustical stand-off. Refer to schedule for applicability.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and coordinate systems and components.

B. All dampers mounted in ductwork with external jackshafts must have the damper position clearly and indelibly marked where visible without removing covers or insulation, preferably by scoring a line across the shaft end parallel to the damper blade position. Removable plastic indicators and felt marker notes are NOT indelible marks. Position indicators must be field-verified at the time of field installation. “Direction of travel” and total travel degrees should be readily apparent or clearly labelled at the actuator.

3.2 INSTALLATION OF DUCTWORK

A. Ductwork Cleanliness:
   1. Reference Standard: SMACNA – Duct Cleanliness for New Construction.
   2. Basic Level:

a. Under this level of ductwork cleanliness it is acknowledged that ductwork leaving the premises of the manufacturer will include some or all of the following:
   1) Internal and/or external self-adhesive labels or marking for part(s) identification.
   2) Exposed mastic sealant.
   3) Sealant shall have a VOC content no greater than 420 g/L.
   4) Light zinc oxide coating on the metal surface.
   5) A light coating of oil on machine formed ductwork.
   6) Minor protrusions into the airway of rivets, screws, bolts and other jointing devices.
   7) Internal insulation and associated fasteners.
   8) Discoloration marks from plasma cutting process.
b. The internal surfaces of ductwork shall be wiped to remove excess dust immediately prior to installation.

3. Intermediate Level:
   a. Under this level of ductwork cleanliness it is acknowledged that ductwork leaving the premises of the manufacturer will include some or all of the following:
      1) Internal and/or external self-adhesive labels or marking for part(s) identification.
      2) Exposed mastic sealant.
      3) Light zinc oxide coating on the metal surface.
      4) A light coating of oil on machine formed ductwork.
      5) Minor protrusions into the airway of rivets, screws, bolts and other jointing devices.
      6) Internal insulation and associated fasteners.
      7) Discoloration marks from plasma cutting process.
   b. Site storage: The area provided for storage shall be clean, dry and exposure to dust minimized.
   c. The working area should be clean and dry and protected from the elements.
   d. The internal surfaces of ductwork shall be wiped to remove excess dust immediately prior to installation.
   e. Open ends on completed ductwork and overnight work-in-progress shall be sealed.
4. Advanced Level:
   a. In addition to the provisions of the Intermediate level the following requirements apply:
      1) All self-adhesive labels for part identification are to be applied to external surfaces only.
      2) To maintain cleanliness during transportation, all ductwork shall be sealed either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapping.
   b. Site Storage:
      1) A clean and dry environment where the ductwork is protected from dust must be provided for the storage of ductwork prior to installation.
      2) All sealed ends shall be visually examined and if damaged resealed with an appropriate material.
   c. The working area shall be clean, dry and the ductwork protected from dust. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
5. Duct Cleanliness levels by space type:
   a. Basic Level:
      1) Ductwork systems serving mechanical or electrical equipment rooms.
   b. Advanced Level:
      1) All Laboratory areas.
      2) Computer, telephone equipment rooms, Data Centers and similar areas housing high tech equipment or fabrication processes.
   c. Intermediate Level:
      1) All building areas not covered under Advanced or Basic Level duct cleanliness (i.e. general office and administration areas, cafeterias, meeting rooms, etc.)

B. Install generally as indicated.

C. Conceal ductwork in finished spaces unless indicated otherwise.

D. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms, or spaces.

E. Exercise special care to provide tight fitting well fabricated, well braced ductwork systems.

F. Field assemble rectangular, round or flat oval ductwork as follows:
   1. Use duct joint sealer applied slip joints.
   2. Use Ductmate, Spiralmate or Ovalmate systems.
   3. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.
   4. Install transverse duct connection systems in accordance with SMACNA construction standards.

G. In high pressure ductwork, do not use two piece mitered 90 degree elbows with or without vanes unless approved by Engineer.

H. Fabricate duct connections for hoods, openings, fans, and other devices.

I. Where ducts pass thru fire rated and smoke rated construction, maintain rating indicated.
   1. Where fire dampers are not used, seal around duct with firestopping.
   2. See Section 07 84 00 for materials.

J. Do not kink, bend or otherwise restrict the free area of flexible ductwork.

K. Ductwork hangers:
   1. Install per SMACNA Duct Construction Standards but in no case shall ductwork hangers or ductwork be directly supported to or supported off of other ductwork.

3.3 SEISMIC CONTROL

A. Seismic Control: Section 20 05 00.

3.4 INSTALLATION OF MANUAL DAMPERS

A. Provide volume dampers, to facilitate air balancing, in the following locations whether shown on the plans or not:
   1. Run-outs to individual room terminal devices (i.e. supply grilles and diffusers, return and exhaust grilles). Locate damper as close to the run-out take off as possible.
   2. Lateral duct take-offs from a return or exhaust main riser for systems serving multiple floors.

B. Provide additional branch main volume dampers required by the balancing contractor, refer to Section 20 08 00.

3.5 INSTALLATION OF FIRE AND SMOKE DAMPERS

A. Install in accordance with manufacturer's instructions and UL requirements.
   1. See Section 07 84 00.

3.6 PERFORMANCE TESTS

A. Test high pressure air ductwork with air pressure not less than 6 IN WG pressure before external insulation is applied.
   1. As required, test portions of system to permit finish work.
   2. Leakage not to exceed maximum values identified by SMACNA HVAC Air Duct Leakage Test Manual.

3. Testing procedures shall be as described by SMACNA HVAC Air Duct Leakage Test Manual.
4. Test all high pressure ductwork systems.

B. Use a pressure blower with volume control and orifice flow meter to provide supply air for test.

C. Submit reports to Architect.

3.7 CLEANING

A. At substantial completion, clean work installed under this section.

3.8 EQUIPMENT DEMONSTRATION

A. At substantial completion, inspect and test, and operate satisfactorily, in presence of Engineer and representative of Owner, operation of each piece of equipment and its accessories.

B. If inspection or test indicates defects, replace defective work or material.

C. Repeat inspections and tests until defects are eliminated.

END OF SECTION

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SECTION 23 35 00
EXHAUST AND VENTILATING FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Air Terminal Units and Induction Units, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
1. High-Plume Dilution Laboratory Exhaust Fans.

C. Abbreviations:
1. ABMA: American Bearing Manufacturers Association.
2. ADC: Air Diffusion Council.
3. AMCA: Air Movement and Control Association.
4. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Standards:
1. ADC Standard 1062R2 - Air Diffusing Equipment Test Code.
2. AFMBA - Method of Evaluating Load Ratings of Bearings (ASA - B3.11).
3. AMCA -99 - Standards Handbook.
4. AMCA 204 - Balance Quality and Vibration Levels for Fans.
5. AMCA 205 – Energy Efficiency Classification for Fans.
6. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
7. AMCA 211 – Certified Ratings Program - Product Rating Manual for Fan Air Performance.
8. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating.
9. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
10. AMCA 311 - Certified Ratings Program.
11. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
12. ANSI Z9.5 - Laboratory Design.
13. ASHRAE - Laboratory Design Guide.
14. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
15. NFPA-90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Product Data:
1. Performance data.
   a. Include maximum allowable RPM for fan construction (tip speed).
2. Physical dimensions.
3. Fan curves.
4. Sound data.

B. Contract Closeout Information:
1. Operation and Maintenance Data.
2. Owner instruction report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. General Fans:
   1. Base:
      a. Members of AMCA.

B. High-Plume Dilution Laboratory Exhaust Fans:
   1. Base:
      a. M.K. Plastics.
   2. Optional:
      a. Cook, Loren.
      b. Greenheck.
      c. Hartzel.
      d. Strobic Air.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Fans - General:
   1. Performance ratings: Based on laboratory tests conducted in accordance with latest edition of ASHRAE/AMCA Standard Test Codes.
   2. UL 705 listed.
   3. Capacity and ratings: As indicated.
   4. Arrangement and drive: As indicated.
   5. Provide removable belt guard.
   6. Fan drive sheaves for belt driven fans over 5 HP:
      a. Cast iron, split tapered bushings dynamically balanced at factory.
      b. Provide initial fixed pitch sheave based upon design conditions.
      c. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
   7. Belt driven fans 5 HP and less: Provide with adjustable sheaves.
   8. Fan wheels shall be statically and dynamically balanced per AMCA Standard 204.
   9. Finish:
      a. Steel fan components: Finished with paint system exceeding 1000 hour salt spray under ASTM B117 test method, minimum 2 mil thick.
      b. Aluminum, galvanized, and stainless steel fan components: Unfinished.

B. Motors and Control:
   1. See Section 20 05 00.
   2. Provide TEFC motor for outdoor installations exposed to weather.
   3. For direct drive fans, provide TEFC motors when motor is located in the airstream.

C. Belt Drives:
   1. Single or multiple belts as required to develop full horsepower of driving motor with service factor of not less than 1.50.
   2. Where more than one belt is used for drive, provide "matched" sets.
      a. Use new belts on final fixed pitch drive sheaves.
   3. Motors on fan drive: Provide with adjustable rail motor mounts of type using screws for tightening of belts.
   4. Bolt motor mounts to fan bases or frames.

D. Belt Guards:
   1. See Section 20 05 00.

E. Control Dampers:
1. Control dampers shall be as specified in Section 23 31 13.
2. Actuator for control dampers shall be as specified in Section 25 50 00.

2.3 HIGH-PLUME DILUTION LABORATORY EXHAUST FAN

A. General:
1. Drive: As indicated.
2. AMCA Construction Class I, II, III as required for the fan to operate at 115 % of design RPM. Construction class shall be increased when necessary to comply with this requirement.
3. Maximum allowable RPM for fan construction (tip speed) shall be indicated on submittals.
4. Single-width, single-inlet (SWSI), as indicated.

B. Housing:
1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Casings to be smooth exterior and resin rich interior.
2. Fan housing shall be manufactured in specifically formulated resins, for maximum corrosion resistance, and reinforced with fiberglass for structural strength. Fastening bolts holding the casing to the support plate are to be encapsulated in FRP. No uncoated metal fan parts in the corrosive air stream will be tolerated.
3. A bifurcated fiberglass reinforced plastic (FRP) discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 7,000 FPM. The discharge shall include a venturi and fiberglass wind band to induce ambient air.
4. All fiberglass parts shall include UV inhibitors in the resins to prevent chalking from the sunlight. Flame retardancy of 25 or less, is standard.
5. A graphite liner and grounding strap shall be included to remove any possible build up of static electricity, if noted on the equipment schedule.
6. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.
7. A bolted housing access door shall be supplied for impeller inspection.
8. Standard finish color to be light gray.
9. Hub seal to be neoprene or Teflon, if noted on the equipment schedule.

C. Fan Impeller:
1. Impellers on 1225 and 1500 fans shall be solid, molded FRP with backward inclined blades.
2. Impellers larger than 1500 shall be backward curved airfoil.
3. A metal backplate integral to the FRP impeller and encapsulated in resin shall have the hub extending to the outside of the fan housing.
4. A tight fitting removable FRP cap shall cover the impeller end of the shaft.
5. Impellers manufactured in coated steel are not acceptable.

D. Bearings:
1. Bearings shall be fixed to the fan shaft using concentric mounting locking collars. Set screws will not be allowed.
2. Self-aligning, extra heavy duty type, ball or roller bearings with regreasable lubrication.
3. Select for minimum average bearing life L-10 rating of 200 000 hours operation at maximum cataloged operating speed.

E. Fan Shaft:
1. Hot rolled and accurately turned, ground, and polished.
2. Sized for critical speed of at least 125 % of maximum RPM.

F. Inlets:
1. Rings: Smoothly contoured to reduce turbulence.
2. Provide removable inlet guards for fans without duct connection.

2.4 VIBRATION ISOLATION

A. Vibration isolation: Section 20 05 50.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's recommendations and as specified.

B. Caulk roof curbs for watertight installation.

C. Coordinate placement of equipment on roof with other trades.

D. Install fans as indicated on the contract drawings.

E. Install FPVC flexible connections with stainless steel straps, provided by the fan manufacturer, between fan inlet and bypass plenum. Ensure that the flexible connection is at least 6 IN wide.

F. Pipe housing drain to the nearest drain.

G. Fans shall be mounted on seismically restrained spring vibration isolators, provided by the fan manufacturer, selected based on fan size, loading conditions and deflection requirements per the fan schedule and specification.

H. Install fans in accordance with manufacturer’s instructions, applicable specification and code requirements.

3.2 VIBRATION ISOLATION

A. Vibration isolation: Section 20 05 50.

3.3 FAN DYNAMIC BALANCING

A. Experienced, trained mechanics from factory shall dynamically balance centrifugal fans 7-1.2 HP and above. Balancing shall include the following:
   1. Inspection of fans to determine if damage has occurred during storage or installation and coordinate repair of damages.
   2. Inspection of fan drives including bearing and motor mounts.
   3. Inspection of tensioning of drive belts on adjustable and fixed pitch sheaves.
   4. X-Y dynamic vibration plot on each fan resulting in a properly balanced installation within factory specifications, performed after system has been balanced and final fixed pitch drive sheaves installed.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS AND INDUCTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for Air Terminal Units and Induction Units, as indicated, in accordance with provisions of Contract Documents.

B. Systems Included:
   1. Air terminal units.
   2. Terminal air valves.

C. Operators and controllers:
   1. Operators and controllers for air terminal units: Provided in Section 25 50 00.

D. Definitions:
   1. Low pressure ductwork: refer to Section 23 31 13.
   2. High pressure ductwork: refer to Section 23 31 13.

E. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Design and installation standards:
   1. ADC Standard 1062R2 - Air Diffusing Equipment Test Code.
   2. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
   3. AMCA Standard 210 - Test Code for Air Moving Devices.
   4. ASHRAE Guide and Data Book – Systems and Equipment, current chapter on duct construction.
   5. ASHRAE Standard 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
   6. NFPA-90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
   7. SMACNA HVAC Duct Construction Standard - Metal and Flexible current edition.
   8. UL Publication No.181 - Erosion Test Methods.

1.3 SUBMITTALS

A. Product Data:
   1. Air terminal units.
   2. Terminal air valves.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.
   2. Owner instruction report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Air Terminal Units:
   1. Base:
      a. Price.

2. Optional:
   a. Accutrol.
   b. Titus.
   c. Krueger.
   d. Trane.

B. Air Valves:
   1. Base:
      a. Phoenix.
   2. Optional:
      a. Accutrol.
      b. Price.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Air Terminal Units.
   1. Air terminal units - general: Factory assembled.
      a. Configured for pressure independent control.
      b. Capacity: As indicated.
      c. Noise level: Based on AHRI 885. Refer to plans for scheduled values.
      d. Operators: Furnished in Section 25 50 00.
         1) Factory or field installed on units.
      e. Acoustical fiberglass liner:
         1) Comply with NFPA-90A for fire resistivity and UL Standard 181 for erosion.
         2) Insulation shall consist of 1 IN thick non-porous foil faced rigid fiberglass insulation secured by full length galvanized steel z-strips which enclose and seal all edges, eliminating tape and adhesives.
      f. Provide multi-point velocity pressure sensors with external pressure taps.
      g. Provide static pressure tube(s).
      h. Valve adjustment: Field adjustable.
      i. Set air terminal units to air flow rates indicated.
      j. Casing leakage: 5 percent, maximum, of nominal rated capacity at 3.0 IN WG internal pressure.
   2. Heating and cooling coils for air terminal units: AHRI certified, continuous plate or spiral fin type, leak tested at 300 PSI.
      a. Capacity: As indicated, based on scheduled entering water temperature, minimum 2 pass.
      b. Headers: Copper or brass.
      c. Fins: Aluminum, maximum 8 fins per IN.
      d. Tubes: Copper, arrange for counter-flow of heating water.
      e. Water velocity: 8 FPS maximum with head loss not greater than indicated.
      f. Provide 20 GA galvanized steel casing with slip and drive construction for attachment to metal ductwork.
      g. Provide vent and drain connection at high and low point, respectively, of each coil.
      h. Coils guaranteed to drain.
   3. Inlet air valves for air terminal units: Corrosion resistant, self-seating type.
      a. Frame, links and levers may be of zinc coated steel or aluminum.
      b. Vanes, pivots, hinged or knuckle joints: Aluminum or other non-ferrous metal.
      c. Leakage: Not greater than 3 percent of maximum rated capacity when closed against inlet static pressure of 4.0 IN WG.
      d. Equip with suitable linkage and motor mounting platform to accommodate control operators.
      e. Use resilient sealing members to prevent leakage.
      f. Provide direct reading air flow rate scale and external adjustment.

4. Air terminal units, single duct, with coils: Constant or variable volume, high velocity unit with reheat coil, as indicated.
   a. Construction: 22 GA galvanized steel or 0.040 IN aluminum, minimum.
   b. Access panel: Gasketed for low leakage and located on bottom of unit and of sufficient size to allow cleaning of the heating coil.
   c. Constant volume units: Factory adjusted volume control: Maintain specified volume for inlet conditions between minimum and 4.0 IN WG.
5. Air terminal unit damper operators and controls: Provide DDC controllers and actuators.
   a. All electrical components including both line voltage and low voltage shall be mounted in a metal control enclosure.
      1) Controls enclosure shall be typically side mount, with bottom mount provided as required for congested areas to maintain code electrical clearance.
      2) Units shall have a single point field wiring connection, with factory-mounted, non-fused type disconnect switch.
   b. The complete system shall be fully operational and include, but not be limited to the following:
      1) Electronic wall thermostat.
      2) Electronic air valve actuator.
      3) Air velocity sensor with temperature set point display.
      4) 24 VAC control transformer(s).
      5) Air pressure switches, as required.
      6) Electronic duct temperature sensors, as required.
   c. Each terminal unit shall be bundled with a digital controller. The controller shall be compatible with a MS/TP BACnet system network. A unique network address and a BACnet site address shall be assigned to each controller, and referenced to the tagging system used on the drawings.
      1) All controllers shall be factory mounted and wired, with the controller's hardware address set, and all of the individual terminal's data pre-loaded into the controller.
      2) The terminal's data shall include, but not be limited to Max CFM, Min CFM, Heating CFM, and terminal K factor. Heating system operating data shall also be factory installed for all terminals with heat.
      3) Communications with the digital controller shall be accomplished through the MS/TP BACnet network. The digital controller shall have hardware input and output connections to facilitate the specified sequence of operation in either the network mode, or on a stand-alone basis.
      4) The terminal unit manufacturer shall coordinate, where necessary, with the Temperature Control Contractor.
6. Piping package: For heating and cooling coils.
   a. Provide a standard factory assembled non-insulated valve piping package to consist of the following:
      1) Control valve: See Section 25 50 00.
      2) Automatic constant flow control valve: See Section 23 21 13.
      3) Isolation valves: See Section 23 21 13.
      4) Inlet strainer. See Section 20 05 19.
      5) Provide unions, manual air vents and/or drains, and pressure-temperature ports for each piping package.
   b. Piping package shall be completely factory assembled, including interconnecting pipe, and shipped separate from the unit for field installation on the coil, so as to minimize the risk of freight damage.

B. Terminal Air Valves.
   1. Air valves, flow control:
      a. Airflow control device shall be a venturi valve.
      b. Pressure independent over a 0.6 IN WG – 3.0 IN WG drop across valve.

c. Volume control accurate to plus or minus 5% of airflow over an airflow turndown range of 16 to 1. No minimum entrance or exit duct diameters shall be required to ensure accuracy or pressure independence.
d. Response time to change in command signal and duct static pressure less than one second.

2. Class A — The airflow control device for non-corrosive airstreams such as supply and general exhaust. 16 gauge spun aluminum valve body and control device with continuous welded seam and 316 stainless steel shaft and shaft support brackets. Pressure independent springs shall be stainless steel. Shaft bearing surfaces shall be Teflon or polyester.
3. Class B — The airflow control device for corrosive airstreams such as fume hoods and biosafety cabinets. 316 stainless steel continuous welded seam valve body, control device, shaft, shaft support bracket, pivot arm and internal mounting link. The control device shall have a baked on corrosion resistant phenolic coating. The shaft shall have a Teflon coating and all shaft bearing surfaces shall be made of Teflon. The pressure independent springs shall be made of stainless steel.
4. Constant volume units:
   a. Internal spring compresses to maintain constant volume of air.
   b. As static pressure decreases internal spring expands to increase annular area to maintain constant volume of air.
   c. It shall be factory calibrated and set for the desired airflow. It shall also be capable of field adjustment for future changes in desired airflow.
5. Certification:
   a. Control device: factory calibrated to airflows detailed on plans using NIST traceable air stations and instrumentation having a combined accuracy of plus or minus 1% of signal over the entire range of measurement.
   b. Electronic airflow control devices: further calibrated and their accuracy verified to plus or minus 5% of signal at a minimum of eight different airflows across the full operating range of the device.
   c. All airflow control devices: individually marked with device specific, factory calibration data to include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers.
6. The shutoff airflow control device shall have shutoff and casing leakage of no more than:

Static Pressure Across Valve in Shutoff	Airflow	Shutoff Leakage	Casing Leakage
5.0 IN WC	Shutoff devices up to 850 CFM	6 CFM	0.12 CFM/FT²
	Shutoff devices up to 1,300 CFM	6 CFM	0.12 CFM/FT²
	Low leakage shutoff devices up to 850 CFM	0.005 CFM	0.010 CFM/FT²
	Low leakage shutoff devices up to 1,300 CFM	0.010 CFM	0.010 CFM/FT²

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as indicated and in accordance with manufacturer's recommendations and instructions and as specified.

END OF SECTION

SECTION 23 58 00
HEAT TRANSFER PACKAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for Heat Transfer Package, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Design standards: ASME and Standard of Tubular Exchanger Manufacturers Association.

B. Factory test: Test sheets and tubes at 300 PSI.

C. Hydrostatically test skid prior to shipping.

1.3 SUBMITTALS

A. Product Data.

B. Contract Closeout Information:
   1. Operating and maintenance data.
   2. Owner instruction report.
   3. Test reports.

1.4 RELATED WORK

A. Refer to Division 25 Integrated Automation Division for instrumentation and controls requirements. See Section 25 50 00 and Section 25 51 00.

1.5 WARRANTY

A. One year guarantee on parts and performance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Heat transfer package:
   1. Base:
      a. Maxi-Therm.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Heat transfer package: Factory assembled instantaneous steam to water unit, including:
   1. Vertical flooded heat exchanger.
   2. Stabilizing pump and motor.
   3. Control valves.
   4. Temperature and pressure gauges.
   5. Temperature and pressure sensors.
   6. Interconnecting piping.
   7. Steam traps.

8. Strainers.
9. Frame.
10. Insulation.
11. Accessories.
12. Condensate mixer.
13. Control panel.

B. Heat exchangers: Vertical flooded heat exchanger.
1. Capacity: As indicated, with steam in shell, water in tubes.
2. ASME stamped.
3. Shell working pressure: 150 PSIG @ 375 °F.
4. Shell: Carbon steel.
5. Heads: Flanged nozzle.
6. Tubes: 90/10 CuNi or 304 stainless steel 1/2 IN OD x 0.049 IN wall and 304 stainless steel tube sheet.
7. Domestic water systems shall utilize double-wall heat exchangers.

C. Stabilizing pump and motor.
1. Sized per manufacturer.
2. Provide with 316 stainless steel check valve and isolation valve.
3. Pre-wired to control panel.
4. See Section 23 21 23.

D. Control valves (Water and Steam):
1. Sized per manufacturer.
2. Pre-wired to control panel.
3. Modulating electric control valve on condensate outlet, fail safe.
4. Over heat security control valve on the steam side, high performance butterfly type with on-off fail closed actuator.
5. Start-up valve, on-off and fail closed, with union orifice.
6. See Section 23 21 13.
7. See Section 23 22 00.

E. Temperature and pressure gauges.
1. Thermometer at liquid inlet and outlet, thermowells included.
2. See Section 20 05 19.

F. Temperature and pressure sensors:
1. Pre-wired to control panel.
2. Electric temperature sensor on liquid outlet.
3. Pressure switch on steam inlet.
4. Flow switch on liquid inlet.
5. See Section 25 50 00.

G. Interconnecting piping (Water and Steam).
1. Water and steam piping in carbon steel SCH40, condensate piping in carbon steel SCH80.
2. See Section 23 21 13.
3. See Section 23 22 00.

H. Steam trap:
1. Float and steam lock release (SLR) steam trap on condensate outlet, flanged.
2. See Section 23 22 00.

I. Strainers (Water and Steam):
1. Strainer 100 mesh with blowdown valve on condensate outlet.
2. See Section 23 21 13.
3. See Section 23 22 00.

J. Frame:

1. Heavy duty painted steel.
2. Coordinated to fit into building without building modifications.

K. Insulation:
1. Post system start-up.
2. Field installed by mechanical contractor.
3. See Section 20 07 00.

L. Accessories:
1. Shipped loose for field installation:
   a. Steam traps for steam drips.
   b. Vacuum breaker (stainless steel) and air eliminator.
   c. Condensate mixer with integrated 316 stainless steel check valve.

M. Condensate mixer:
1. Provide with integrated short stroke, spring actuated check valve.
   a. Required to enable a high pressure drip trap to discharge in a flooded low pressure condensate main without water hammer.

N. Control panel: Unit mounted and wired NEMA 4-12 control cabinet with temperature controller and hinged doors.
1. Programmed to perform the start-up, temperature control operation, and shut down procedures, as well as alarms managing.
2. Dry contacts provided for remote start-up and alarm monitoring, and an analog output signal to be used to monitor the liquid outlet temperature or the control valve opening. An analog input available for remote set point change.
3. 115V, 15A power supply by others.
4. Combination magnetic starters with 3 leg overload protection, fused disconnect and cover interlock.
5. "Auto-Off-Hand" selector switch.
6. Numbered terminal strip.
7. Fused control transformer for each circuit.
8. UL listed components.
9. The heat transfer package controller shall provide native controls communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install heat transfer package in system piping as indicated and in accordance with manufacturer's instructions.

3.2 START-UP

A. To be performed by the manufacturer or authorized representative.

END OF SECTION

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SECTION 23 73 23

FACTORY BUILT CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Factory Built Custom Air Handling Units, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Standards:
   1. ADC-1062R2, Air Diffusing Equipment Test Code.
   2. AMCA-210, Test Code for Air Moving Devices.
   3. NFPA-90A Standard for the Installation of Air Conditioning and Ventilating Systems, 1993 edition.
   4. AHRI-410 - Forced-Circulating Air-Cooling and Air Handling Coils.
   5. AHRI-430 - Standard for Central Station Air Handling Units.
   6. AMCA-99 - Standards Handbook.
   7. AMCA-204 – Methods and Standards for Fan Balancing.
   8. AMCA-210 - Laboratory Methods of Testing Fans for Rating Purposes.
   9. AMCA-300 - Test Code for Sound Rating Air Moving Devices.
   10. AMCA-301 - Method of Publishing Sound Ratings for Air Moving Devices.
   11. AMCA-500 - Test Methods for Louver, Dampers, and Shutters.
   12. ANSI/AFBMA-9 - Load Ratings and Fatigue Life for Ball Bearings.
   13. ANSI/AFBMA-11 - Load Ratings and Fatigue Life for Roller Bearings.
   14. ASHRAE-62 - Ventilation for Acceptable Indoor Air Quality.
   15. UL-508 - Standard for Industrial Control Panels.
   16. UL-1995 - Standard for Safety - Heating and Cooling Equipment.

B. Construction Standards and Criteria:
   1. Unit Construction Pressure Class: 8 IN static pressure, positive and negative.

C. Minimum Quality Control Requirements and Performance:
   1. Factory balancing:
      a. Fan wheels and shaft assemblies shall be factory balanced both statically and dynamically to meet AMCA 204 standards for residual unbalance.
   2. Fan performance curves:
      a. Tests shall be conducted in a certified AMCA laboratory in accordance with current AMCA Standards.
   3. Leakage: No more than 1 % of air handling unit cfm at 8 IN static pressure.
   4. Panel deflection: No more than 1/240 of an inch.
   5. Coils:
      a. Coils shall be factory tested to 325 PSI compressed air under clear water.
   6. Air handling units shall be designed and manufactured in strict accordance with UL-1995, Standard for Heating and Cooling Equipment. All units shall be listed and shall bear the UL 1995 label.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Dimensional shop drawings:
      a. Show casing construction (base, floor, housing).
      b. Access door hardware.

c. Operating weight (point and distributed loads).
2. Filter frames.
3. Fan/motor vibration isolation details.
4. Field connection details.
5. Required clearances.
6. Predicted sound data at eight octave bands for each opening in the unit.
7. Roof curbs.

B. Product Data:
1. Casing thermal performance.
2. Fan data:
a. Sound power levels based on fan arrangement in unit.
b. Certified fan curves at following conditions:
1) Scheduled operating conditions including initial and final as noted.
2) 50 % airflow operating condition (used to evaluate potential surge conditions).
c. Computer selections based on schedule performance criteria.
d. Motor electrical characteristics.
3. Filters.
4. Coil data:
a. Computer selections of based on scheduled performance criteria.
5. Dampers.
6. Sound attenuators.
a. Certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance for reverse and forward flow test conditions.
7. Vibration isolation components.
8. Roof curbs.
a. Seismic/wind calculations.

C. Contract Closeout Information:
1. Operation and Maintenance Data including:
a. Bearing lubrication instructions.
b. Filter replacement instructions.
c. Motor and drive replacement instructions.
d. Wiring diagrams.
2. Owner instruction report.
3. Field pressure test report on cabinet casing, with access doors in place.
1) Report to factory certify air handling unit cfm leakage rate.
4. Warranty.

1.4 WARRANTY

A. Provide full parts and labor manufacturer warranty to include all parts, labor, travel time, and incurred expenses. Warranty to cover from date of start up to date of substantial completion, plus an additional 24 month full parts and labor manufacturer warranty from date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Factory Built Custom Air Handling Units:
1. Base:
a. Trane.
2. Optional:
a. JCI/York.
b. Racan.
c. Hunt Air.

d. Haakon.
e. Temtrol.
f. Ventrol.
g. Governair.

B. Filters:
1. Base:
a. American Air Filter.
2. Optional:
a. Tri-Dim.
b. Eco-Air Products.
c. Cam-Farr.
d. Flanders.

C. Roof Curb:
1. Base:
a. Thybar.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Thermal Break Construction:
1. Unit shall be guaranteed not to form surface condensation under the following conditions:
a. Interior dry bulb temperature: 50 °F.
b. Exterior dew point temperature: 70 °F.

B. Unit Base:
1. Air handling unit base:
a. Material: Heavy duty structural steel channel; formed metal base structure is not permitted.
b. Channels: Solid welded at connection points to assure rigidity.
1) Perimeter channel: Sized to allow for rigging and handling.
c. Base cross supports: Located and sized to support internal components.
1) Internal supports: Properly spaced to avoid oil canning of unit floor above.
2) Cope structural members that intersect with open side of channels or add filler piece to assure structural integrity.
d. Equipment eight feet wide and wider: Provide with a means of supporting center of unit on a truck.
e. Lifting lugs: Add to perimeter channel along longest length of unit or unit module.
1) Position and/or extend each lug to avoid any obstruction which extends beyond unit casing, including piping vestibules, surface mounted electrical or control panels, piping connections, and other appurtenances affixed to the unit exterior housing.
2) Incorporate into each lug a means of attaching a cable or chain.
f. Split in maximum size pieces to allow for economical shipment to jobsite.
1) Coordinate with installation conditions on site.
2. Base drain pans:
a. Provide as integral part of unit base in following sections:
1) Cooling coil section.
2) Outside air inlet and mixed air sections.
b. Where drain pans exist in adjacent sections, weld adjacent drain pans together water tight.
c. Double wall construction of type 304 stainless steel.
1) Drain pan underliner: Type 304 stainless steel filled with insulation to provide a minimum R-7 insulation assembly.
a) Underliner not required for foam insulation.

2) Provide 2-1/2 IN wide, 12 gauge type 304 stainless steel inverted channels on a maximum of 24 IN centers to reinforce pan to support coils.

d. Size:
1) Minimum width: .
a) Pitch in direction of air flow to assure water migration.
b) Drain pan shall extend a minimum of 12 IN downstream of the cooling coil.
c) Drain pans in mixed air sections: Extend the width of the section.
d) Drain pans in outside air inlet sections:
(1) Top inlet: extend from the edge of the next upstream component to the edge of the next downstream component.
(2) Back inlet: extend from the face of the inlet to the next downstream component but no less than 48 IN.

e. Clearances:
1) Provide adequate clearance, but not less than 2 IN, between bottom of the inverted coil mounting channels and top of the drain pan to allow for visual inspection and cleaning of the drain pan without coil removal.
a) Coil height, including the coil casing material, shall not extend into the drain pan height.
b) Coil supports shall be arranged to allow the coil to be removed to one side of the air handling unit by removal of pipe connections and one cabinet wall panel and sliding the coil horizontally (above the drain pan height) on the coil supports.

f. Drain pan slope:
1) Double or triple slope drain pan, minimum of 1 %, and pitched toward drain connection side.

g. Provide drain connections on one side of unit where floor drain(s) are located.
1) Construct drain lines of same material as pan.
2) Extend drain lines through perimeter base channel and continuously weld seams/penetrations to insure an air-tight seal.
3) Provide removable cap on each drain connection.

C. Unit Floor:
1. Air handling unit floor:
a. Minimum 12 gauge G90 galvanized steel, or minimum 3/16 IN thick aluminum treadplate.
b. Space welds from below floor no greater than 4 IN on center.
c. Space welds from top of floor no greater than 1-1/4 IN on center.
d. Drive screw attachment is not acceptable.
e. Floor construction: Double wall and constructed to meet L/240 deflection based upon 300 LB concentrated load at mid-span.
f. For adequate support, provide a base structural member centered under edges of each sheet of flooring material.
1) Seal floor seams with a continuous bead polyurethane sealant.
2) Base supports above floor are not acceptable due to hazards to service personnel.
g. Overlap floor on perimeter base channel to allow a means of attaching cabinet panels from exterior without penetrating structural steel.
h. Lay floor flat and flush with top surface of base channel.

D. Unit Housing:
1. Air handling unit housing:
a. Wall construction:
1) Double wall, panelized construction such that all internal components can be easily accessed for service or removal without removal or disassembly of any exterior wall sections or panels or roof sections or panels.
2) Material: G90 galvanized steel.
a) Minimum 20 gauge for foam insulation construction.

b) Minimum 16 gauge for fiberglass insulation construction.
3) Deflection: L/240 at static pressure equivalent to Unit Construction Pressure Class.

b. Exterior air handling units:
1) The air handling unit shall be specifically designed for outdoor application.
2) Roof curb:
a) Prefabricated, minimum 12 GA galvanized steel mounting curb, meeting ASTM A653/653M, with welded corners and with seams joined by continuous water and air tight welds, designed and manufactured by unit manufacturer for exterior units only.
b) Minimum 1-1/2 IN, 3.0 PCF density rigid insulated walls and floor pans, with solid sheet metal liners.
c) Verify field conditions prior to unit shipment.
d) Complete perimeter support of unit.
e) Top of all roof curbs shall be level, with pitch built into curb when deck slopes.
f) Internally reinforced with angles 48 IN on center.
g) Minimum 32 IN high or as detailed.
h) Nominal 2 x 4 IN wood nailer strip.
i) Provide gasketing for field mounting between unit base and curb, and between curb and roof deck.
j) Built to restraint equipment for the seismic/wind criteria, with applicable restraint brackets to solidly attach unit to curb and anchor curb to roof deck.
3) Roof panels: Sloped or bowed roof with a minimum of 1/4 IN/FT slope to ensure rain runoff.
a) Provide a rain lip or gutter around perimeter of roof to prevent water from running down side of unit. Provide rain lip above doors and intake louvers.

2. Supply and return openings:
a. For supply air, provide openings with rectangular, round, or oval wide radiused, bellmouth fittings and duct collars to accept supply and return air connections as indicated.
b. Provide removable G90 galvanized steel grating over floor openings inside of air handling unit.
1) Weight support: capable of supporting 300 LBS.
2) To avoid tripping hazard, grating shall be flush with the finished floor of the unit.

3. Unit split modules:
a. Provide necessary hardware to reassemble equipment such as bolts, nuts, washers, sealant, and slip cleats.
b. Mark each corresponding module of cabinet with matching letters to assist in reassembly.

4. View windows: provided in access doors.
a. View window frame: Fabricated from 16 gauge galvanized steel.
b. Provide 3/4 IN thick thermopane wire glass window.
c. Seal window frame to cabinet with open cell gasket on sides to ensure an air tight seal.
d. Window open viewing size: 12 IN x 12 IN.
e. View windows at sections with UV lights (installed or noted for future install): Provide UV filtering glass.

E. Unit Insulation:
1. Air handling unit insulation - general:
a. Meet NFPA-90A smoke and flame spread requirements.
b. Provide insulation materials with facings that will not promote microbial growth.
c. R-value of wall, roof and floor assemblies: minimum of R-12.
d. Type: Foam or fiberglass.

F. Unit Liners:
1. Liners - general:
a. As a protective cover for insulation, provide liners on the interior of the air handling unit integral parts of the exterior panel system.
b. Consolidate internal reinforcing as well as interior lining surface into one piece.
1) Allow attachment of interior liner to cabinet without exposing any drive screws or bolts which can be hazardous to service personnel.
2) Provide a smooth, uninterrupted surface.
3) Exposed reinforcing is unacceptable due to impedance of air performance.
2. Solid liner:
a. Liner material: Minimum 20 gauge G-90 galvanized steel, except where specifically indicated otherwise.
b. Liner material in wetted sections: Minimum 20 gauge type 304 stainless steel.
1) Provide in following sections:
a) Cooling coil section.
b) Supply fan section.
c. Do not allow exposure of any insulation to air stream.
d. Fabricated from a solid sheet without any perforations.
e. Cover openings and corners to completely contain insulation.
3. Perforated liner:
a. Liner material: G-90 galvanized steel.
b. Provide in following sections:
1) Fan sections.
2) Supply air plenum section.
c. Protect insulation while allowing acoustical absorption.
d. Perforations: 1/4 IN diameter.
1) Minimum allowable free area: 40 %.
e. Insulation containment: totally encapsulated and sealed with a polymer film. Separate fill material from perforated baffle by a non-combustible, erosion resistant, acoustical stand-off.

G. Unit Finishes:
1. Exterior finish: Wall and roof panels.
a. One coat of polyurethane primer and one coat of polyester-hybrid semi-gloss top coat.
1) Prime and top-coat panels on both sides.
2) Color: Manufacturer's standard.
3) Paint system shall pass a minimum of 1000 hour salt spray test per ASTM-B117.
2. Base finish:
a. Alkyd enamel.
1) Provide industrial grade alkyd enamel red oxide primer by air brush to 2 mils thickness.
2) Provide alkyd enamel top coat with air brush to 2-3 mills thickness.
b. Color: Manufacturer's standard.
3. Fan assembly finish:
a. One coat of polyurethane primer and one coat of polyester-hybrid semi-gloss top coat.
1) Prime and top-coat panels on both sides.
2) Color: Manufacturer's standard.
3) Paint system shall pass a minimum of 1000 hour salt spray test per ASTM-B117.
b. Aluminum fans shall not require paint finish.
4. Interior finish:
a. Paint non-galvanized or welded surfaces with red oxide primer and machinery gray enamel.

H. Fan Assembly:
1. Performance ratings: rated in accordance with laboratory tests conducted in accordance with AMCA Standard 210.

2. Ratings: As indicated.
3. Arrangement: As indicated
4. Drive sheaves: Cast iron with split taper bushings dynamically balanced at factory.
   a. Provide wide range variable speed, adjustable sheaves to be used for balancing systems.
5. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
6. Fan Array Technology (Plurality of fan arrangements):
   a. Multiple direct driven, arrangement 4 plenum fans constructed per AMCA requirements for duty specified, (Class I, II, or III).
   b. Multiple fan/motor "cells", spaced in the air way tunnel to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
   c. All fans shall be selected to deliver design air flow at the specified operating TSP (Total Static Pressure) at the specified motor speed as scheduled.
   d. The fan array shall be selected to operate at a system TSP that does not exceed 90 % of the specified fan's peak static pressure producing capability at the specified fan speed.
   e. Performance:
      1) The fan array shall produce a uniform air flow profile and velocity not to exceed the specified cooling coil and filter bank face velocity when measured at a point 12 IN from the intake side of the Fan Wall array septum wall, and a distance of 42 IN from the discharge side of the Fan Wall array septum wall.
      2) Fan shall be structurally designed to withstand the maximum motor RPM at 60 hertz.
      3) The fan array shall be installed such that the optimum system operating efficiency may be achieved by manually, or automatically, enabling or disabling fans in the array to provide the minimum connected HP for the fan array that is necessary to produce the required air flow and pressure in the system. The fan array shall be configured such that the connected HP at reduced flow conditions may be less than the installed total HP of the fan array in order to achieve optimum system efficiency. Each fan cube shall be individually wired to a control panel containing a single VFD(s) for the total connected HP for all fan motors contained in the fan array.
      4) The fan array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^-12 watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the Air Handling Unit when compared to the same fan array unit without the silencer array.
         a) Alternate manufacturers must submit acoustical data for review and approval prior to the bid indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP for each fan array. Proposals submitted which indicate a higher connected fan HP than specified or scheduled will not be accepted.
   f. Fan/motor cartridge:
      1) Each fan/motor cartridge shall consist of:
         a) Steel intake wall: 11 gauge A60 galvanized steel.
         b) Inlet funnel: 14 gauge spun steel.
         c) Motor support plate and structure: 11 gauge A60 galvanized steel.
         d) All components to be powder coated epoxy for enhanced corrosion resistance.
         e) Motors: See Section 20 05 00.
            (1) Shall be selected by the manufacturer and suitable for array application.
            (2) Efficiency: NEMA premium efficiency in compliance with MG-1.

f) Each fan/motor cartridge shall be removable through a 30 IN wide, free area, access door located on the discharge side of the fan array.

g. Balancing:
1) Each fan array and assembly shall be dynamically balanced to meet the following requirements of AMCA standard 204:
a) Category: BV-5.
b) Grade: G 1.0.
c) Residual unbalance: equal to or less than 0.0028 oz-in/lb of rotor mass.

h. Drives and wiring:
1) Each supply fan motor shall be individually wired to a control panel containing a single VFD, sized for total connected horsepower for the supply fan array. Provide similar wiring and separate control panel/VFD for the return fan motors. Refer to Section 25 23 00 for VFD requirements.
2) Wiring sizing shall be determined in accordance with NEC standards.
3) Fan shall be structurally designed to withstand the maximum motor RPM at 60 hertz.

i. Isolation backdraft dampers: Provide on discharge of all fan array modules.

j. Safety screens at fan discharge: Provide on all fan array discharge modules.

k. Sound Pressure Levels:
1) Unit inlet and outlet discharge sound pressure levels and radiated sound pressure levels shall not exceed the values scheduled for the or alternate single direct drive plenum fan.
2) Alternate fan systems:
a) If alternate conventional fan systems are proposed by the contractor it shall be the responsibility of the contractor proposing the alternate to guarantee that noise levels in the occupied space will not exceed the basis of design fan array system.
b) Any acoustical treatment for alternate fan systems must be approved by the engineer and architect prior to installation, and any such acoustical treatment or subsequent treatment will be done at the sole expense of the contractor proposing the alternate fan system.

7. Air flow measuring stations: Comply with Section 25 50 00.
a. Factory install air flow measuring stations in the inlets of the supply and return fans. For units with multiple supply and return fans, mount stations such that any fan blank off panels can be mounted so they do not disturb air flow station.
b. Inlet venturi cone/ring may be used with airflow station transmitter as specified in Section 25 50 00.
1) Device shall meet or exceed airflow station requirements identified in Section 25 50 00.
c. Transmitters specified in Section 25 50 00 may be field or factory installed.

I. Economizer:
1. Economizer section includes:
a. Dampers and linkage for return air, outside air, and exhaust/relief air.
b. Drain pan.
2. Dampers, control:
a. Provide control dampers for return, outside and exhaust/relief air.
1) Control dampers: As specified in Section 23 31 13, factory mounted.
2) Damper actuators: As specified in Section 25 50 00, field or factory mounted.
3) Size dampers with 1500 to 1800 FPM air velocity.
4) Outside and return air dampers: Parallel blades arranged to provide convergent airflow to minimize stratification.
5) Outside air dampers:

a) Provide two control dampers in each unit. One shall be sized for scheduled minimum outside airflow, and the other shall be sized for the design supply airflow less the minimum outside air quantity.

3. Drain pan: double sloped to assure positive condensate drainage with connections on one side located adjacent to floor drain. The pan shall be of double wall construction with a stainless steel liner and have a minimum of 2 IN of insulation (uncompressed). The pan shall have a minimum depth (free-board) of 2 IN.
4. Exterior air handling units:
   a. Provide exhaust/relief louver or weather hood complete with bird screen to prevent infiltration.
   b. Provide outside air introduced through intake weather hood complete with bird screen to prevent infiltration.

J. Filter Banks:
1. Filter banks (filter frames with filters) - General:
   a. Factory fabricate as part of air handling unit.
   b. Mount filter bank in air handling unit.
      1) Continuously bond periphery of filter frame to inside of air handling unit to eliminate air bypass.
2. Filter frames - General:
   a. Provide frames compatible with filters scheduled.
   b. 16 gage galvanized steel.
   c. Equip frame with protective diagonal support members on both air entering and air exiting sides of filters.
   d. Equip frame with gaskets and heavy-duty, positive-sealing fasteners capable of being attached or removed without use of tools.
   e. Filters shall be accessible from inside the unit.
3. Filters:
   a. Capacities and types: As scheduled.
   b. Locations: As scheduled.
   c. UL Class 2 listed.
   d. Provide quantities and standard sizes to match requirements of air handling unit.
   e. Provide two sets of pre-filters and final filters.
4. Pre-filters: Extended surface panel type.
   a. Provide two sets of prefilters.
   b. Average media efficiency: As scheduled.
      1) Efficiency is based on ASHRAE Test Standard 52.1.
   c. Double-wall, moisture-resistant beverage-board frame.
   d. Adhere media pack to interior of frame at points of contact (sides, entering face, and leaving face).
   e. Pleat support grid: Welded wire or expanded metal.
5. Final filters:
   a. Filters: Rigid cartridge type.
      1) High performance, deep pleated, totally rigid and totally disposable type with high density microfine glass fiber media, media support grid, contour stabilizers and enclosing frame.
      2) Average media efficiency: As scheduled.
         a) Efficiency is based on ASHRAE Test Standard 52.1.
      3) Filters arranged for face loading into positive sealing "type 8 IN filter frames.
      4) Constructed by pleating a continuous sheet of moisture-resistant water-laid micro-fine glass media into closely spaced pleats with hemmed-edge corrugated aluminum separators.
      5) Sealed into a 24 gauge galvanized steel frame with fire-retardant potted urethane elastomer sealant.

6) Frame:
a) Enclosing frame: Assembled in a rigid manner and incorporate a single or double header as required for job conditions.
b) Headers: Gasketed with polyfoam on vertical sides to prevent leakage when installed in framing modules.

6. For each individual filter bank, provide Dwyer Series 2000 magnahelic filter gauges, with adjustable signal flag and sun shield enclosure for exterior units.
7. Provide walk-in filter access sections upstream of filter rack with adequate space available for filter service.

K. Coils:
1. Coils - general:
a. Certified in accord with AHRI 410.
b. Coil capacity, size and type: As scheduled.
c. Arrange coils for easy removal.
d. Coil support rack:
1) Mount coils on support rack.
2) For stacked coils, lower coil sections shall be capable of being removed without disturbing upper coil sections.
3) Rack construction:
a) Heating coils: 16 gauge G90 galvanized steel
b) Cooling coils: 16 gauge 304 stainless steel.
e. Blank off coil ends to ensure air passes through the coils.
1) Heating coils: 12 gauge G90 galvanized steel
2) Cooling coils: 12 gauge 304 stainless steel.
f. Working Pressure Rating:
1) Water coils: 250 PSIG.
g. Temperature Rating: 300 °F.
h. Coil Connections:
1) Threaded connections located on same end, except where otherwise noted or shown.
2) Coil headers, distributors and connections completely enclosed in unit casing.
3) Water coil vent and drain connections:
a) Provide for each section.
b) Extend all vents and drain lines to the exterior of the unit housing.
c) Locate on the same side of the unit as the supply and return piping.
d) Interior manifolding of individual coil drain and vent lines, prior to extending to the unit exterior is not acceptable.
2. Water Heating Coils:
a. 5/8 IN OD copper tubes, 0.025 IN wall; 0.035 IN wall on return bends.
b. 1/2 IN OD copper tubes, 0.022 IN wall.
c. Minimum 0.0075 IN thick aluminum fins, spiral or plate fin design.
1) The maximum fin spacing shall be 10 FPI.
d. 16 gauge G90 galvanized steel casing.
e. Non-ferrous, copper headers.
3. Chilled Water Cooling Coils:
a. 5/8 IN OD copper tubes, 0.025 IN wall; 0.035 IN wall on return bends.
b. 1/2 IN OD copper tubes, 0.017 IN wall.
c. Minimum 0.0075 IN thick aluminum fins, plate fin design.
1) The maximum fin spacing shall be 14 FPI.
d. 16 gauge type 304 stainless steel casing.
e. Non-ferrous, copper headers.
4. Intermediate condensate drain pans:
a. On stacked cooling coils, provide intermediate pan to prevent condensate from upper coil(s) from passing over lower coil(s).

b. Intermediate drain pans shall be insulated with 1 IN elastomeric insulation on the underside to prevent condensation formation and moisture carry-over due to adiabatic condensation formation on the intermediate drain pans.
c. Fabricated from same material and in same style as base drain pan.
d. Provide 1 IN diameter, 304 stainless steel or copper down spouts from upper pan(s) to lower pan(s).

L. Sound Attenuators:
1. As specified in Section 23 31 13: Air Distribution System. Sound attenuators in unit shall be factory installed.

M. Access Doors:
1. Access doors: Hinged, double wall, insulated, thermal break type.
a. Provide in following sections:
1) Fan sections.
2) Access sections.
3) Filter sections.
4) Supply and return plenums.
5) Section(s) where damper(s) are located (such as economizer section).
b. Provide additional access doors where shown on drawings.
c. Door construction:
1) Door size, minimum: 24 IN wide x 72 IN high.
2) Size door(s) to accommodate removal of following equipment through the door(s):
a) Motors.
3) Exterior door skin: Same material and finish as unit housing.
4) Door interior liner: Same material and finish as interior liner of section in which door is installed.
5) Access door perimeter: One piece, welded.
6) Insulation: Same as unit wall insulation.
d. Door frame: One piece, welded.
e. Gasketing:
1) Provide full circumference gasketing with a closed cell, replaceable neoprene gasket.
2) Provide gasketing system that allows for easy removal for replacement.
3) Provide system that will maintain a tight seal without assistance of operating pressure.
f. Hinges and latches:
1) Provide corrosion resistant, fully adjustable hinges and latches to allow for maintenance of a tight seal between door and unit as gasketing material compresses over time.
2) Provide stainless steel, removable hinge pins to allow door to be easily removed during servicing.
3) Leaf and Piano type hinges are not acceptable.
4) Provide for padlocking of latches to fan sections.
5) Latch and paw assemblies: One piece, bolted together.
g. Hinge access doors so they open against unit operating pressure unless otherwise indicated.

N. Pressure Relief Doors:
1. Pressure relief doors: Provide vertically mounted pressure relief doors in the supply air plenum and the return air plenum.
a. Quantity: As indicated.
b. Frame: 12 GA galvanized steel, Z shaped.
c. Door: 12 GA galvanized steel.
d. Seal: Polyurethane foam around door perimeter.

e. Pressure setting:
   1) Supply plenum: X IN WG positive.
   2) Return plenum: X IN WG negative.
f. Springs: Negator type for door closure upon loss of over pressurization.
g. Size: 18 IN x 18 IN.
h. Insulation: For the supply plenum pressure relief, provide 1 IN thick foil faced insulation on the inside surface.
i. Comply with Section 23 31 13.

O. Electrical:
1. Wiring to comply with NEC requirements and conform with applicable UL standards and Electrical Specification Divisions.
2. Each unit shall be wired and tested at the factory before shipment.
3. Provide separate factory wired branch circuits for each supply and return air fan motors.
4. Variable frequency drives for exterior air handling units:
   a. Variable frequency drives (VFD): As specified in Section 25 23 00.
   b. Factory mount VFD(s) in compartment integral with, and cooled with air from, the air handling unit.
   c. VFD(s) to be mounted and pre-wired to motor.
   d. VFD(s) to be interfaced with and controlled by Owners existing Building Automation System (BAS).
5. Lights:
   a. Provide one factory installed light for each air handling section which has an access door.
   b. Fixture: Light emitting diode (LED) type with gasketed weather-resistant housing.
   c. Each fixture shall be controllable from externally mounted light switch with pilot light. Exterior units shall have weatherproof switch.
   d. Provide a separate 120 Volt factory wired circuit for unit lights. Terminate circuit at junction box at unit's exterior.
   e. At shipping sections, provide additional junction boxes on each module to allow the installer to make final connections in the field.
      1) Clearly label wiring to ease final interconnections.
6. Outlets:
   a. Provide one factory installed double grounded GFCI receptacle for each air handling fan section. Exterior units shall have weatherproof receptacles.
   b. Provide a separate 120 Volt factory wired circuit for unit receptacles. Terminate circuit at junction box at unit's exterior.
   c. At shipping sections, provide additional junction boxes on each module to allow the installer to make final connections in the field.
      1) Clearly label wiring to ease final interconnections.

2.3 VIBRATION ISOLATION

A. Vibration isolation: See Section 20 05 50.

2.4 FIELD UNIT TESTING

A. Air leakage test:
1. Pressure test unit to positive and negative 8 IN WG.
2. Leakage shall not exceed 1 % of unit design airflow volume.
3. Submit test report.

B. Panel deflection test:
1. Panel deflection checks shall be done in conjunction with and at pressures stated in pressure leak test.
2. Once unit is leak tested and determined to be acceptable, a panel deflection test may be conducted. Deflection will be measured at four (4) points around the cabinet. Each point will be located at the largest unsupported span for the side. A dial micrometer will be

placed against panel seam at the mid-point of the panel height. The cabinet will be pressurized to the specified static load and the deflection will be measured.

3. Pass/Fail criteria will be based on 1/240 of the panel span as a maximum allowable deflection at specified static load.
4. Submit test report.

C. The Owner/Architect shall be given the option to witness the tests at their own expense.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field assemble air handling unit modules in accordance with manufacturer's installation drawings and instructions.
   1. Assemble unit complete with vibration isolation components.
   2. Sealing and fastening hardware shall be supplied by air handling unit manufacturer.
   3. Pour concrete for fan inertia bases.
   4. Provide lamps for lights.

B. Touch-up abraded or damaged finish.

C. Provide a trap on drains at jobsite on exterior of unit.
   1. Traps shall be adequate to maintain a water seal while equipment is in operation

D. Coordinate with Section 25 50 00 for location of water valves, temperature sensors, and damper operators.

E. Install final fixed sheaves furnished by air handling manufacturer.

F. Provide fan dynamic balancing services as specified in Section 23 35 00.

3.2 START-UP

A. Provide services of factory trained service technician to inspect units after erection, perform minimum 16 hour startup service and perform concurrent Owner instruction.
   1. File written report and include in maintenance manual.
   2. Coordinate startup with Test and Balance provider and Temperature Controls provider.

B. Equipment Startup:
   1. Unit start-up to take place at completion of future Fit-up package work.
   2. Prior to the engineer's scheduled startup, complete the following:
      a. Ensure automatic temperature controls work is complete.
      b. Turn on power, and "bump" unit motors to verify correct fan rotation.
      c. Remove shipping materials.
      d. Ensure that spring isolated components are off shipping supports.
      e. Level spring isolated components.
      f. Install filtration media in equipment.
         1) Replace filters used in construction.
      g. Complete piping and duct connections.
         1) Complete leak checks on water piping prior to startup.
      h. On multiple piece units, complete interconnections (electrical, piping and ductwork) and roof joints.
      i. Make startup requests to manufacturer two weeks prior to scheduled date.
   3. Temperature control and air balance providers shall be on site at time of equipment startup.

END OF SECTION

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SECTION 23 82 39
HYDRONIC HEATING TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Hydronic Heating Terminal Units, as indicated, in accordance with provisions of Contract Documents.

B. Description of system:
   1. Fan coil units.

C. Work installed but not furnished:
   1. Control valves: Furnished under Section 25 50 00.

D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Standards:
   1. Methods of Testing for Rating Fan-Coil Air Conditioners: ASHRAE-79.
   2. Room Fan-Coil Air Conditioners: AHRI-440.
   3. Safety Standards for Fan Coil Units and Room Fan Heater Units: ANSI/UL-883.
   4. Advanced Installation Guide for Hydronic Heating Systems: IBR-250, 2nd Edition.
   5. American Society of Testing and Materials (ASTM):
      a. E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 1382 °F.
      b. C 553 Standard Specification for Mineral Fiber Blanket and Felt Insulations.
      c. C665 Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

1.3 SUBMITTALS

A. Product Data:
   1. Fan coil units.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.
   2. Owner instruction report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fan coil units:
   1. Base:
      a. Trane
   2. Optional:
      a. Energy Labs
      b. Carrier
      c. Daikin
      d. Dunham-Bush
      e. International Environmental

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Fan Coil Units:
1. Fan coil units, horizontal: Draw thru type with heating and cooling coils, centrifugal direct-driven fan, filters and drain pan.
   a. Capacity: As scheduled.
   b. Casing: 16 GA galvanized steel with side access panels for maintenance and service.
   c. Coils: Copper tube, aluminum plate fins.
      1) Leak tested at 300 PSIG minimum air pressure.
      2) Automatic air vent.
   d. Fan: DWDI forward curved, centrifugal type.
      1) Permanently lubricated, long life bearings.
      2) Dynamically balanced.
   e. Drain pans: Integrally attached to coil casing.
      1) Drain pipe connection.
      2) Stainless steel with molded polystyrene foam insulating liner.
   f. Filters: 2 IN MERV flat pleated 8 type.
   g. Motors: Electronically Commutated Motors (ECM), see Section 20 05 00.
      1) Provide with built-in thermal overload protection.
   h. Provide discharge duct collar integral with casing.
2. Piping package:
   a. Provide piping package complete with 4-stop valves, automatic air vent for each coil and electric 2-way valve for each coil.
   b. Electric modulating 2-way valve: Furnished under Section 25 50 00.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

END OF SECTION

SECTION 25 23 00
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Variable Frequency Drives, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of seven (7) years in manufacture and operation of pulse width modulated (PWM) drives in sizes indicated.

B. UL and or Electrical Testing Laboratories listed and labeled.

C. Tested to ANSI/UL-508A.

D. Plenum rated applications: Tested to ANSI/UL-508C.

E. Meet requirements of IEEE Standard 519, latest edition, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters".

F. Local service representative's qualifications:
1. Provide and maintain field service personnel authorized by Manufacturer to perform service both in and out of warranty.
2. Maintain full stock of service parts for all units furnished.
3. Provide in-depth training in operation of all units.

G. Manufacturers to ISO 9000 certified.

1.3 SUBMITTALS

A. Shop Drawings:
1. Dimensional drawings.
2. Power circuit drawings.
3. Control connection drawings.

B. Product Data:
1. VFD's maximum rated output amps.

C. Project Information:
1. Factory test reports.

D. Contract Closeout Information:
1. Operation and Maintenance Data.
2. Owner instruction report.
3. Factory start-up and field test reports.
4. Warranty.

1.4 WARRANTY

A. Warranty:
1. 12 months from date of startup, not to exceed 18 months from date of shipment.
   a. Include all parts, labor, travel time and expenses.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Variable Frequency Drives:
   1. Base:
      a. Danfoss-Graham.
   2. Optional:
      a. Toshiba
      b. Yaskawa.

B. Fuses:
   1. Base:
      a. Bussmann.
      b. Shawmut.
      c. Rockwell Automation.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. General:
   1. Variable frequency drives (VFD): Provided with full wave inverters (rectifiers) to convert three-phase, 60 Hz AC power to DC power, and inverters to "invert" DC power back to a variable frequency, three-phase AC power.
      a. Line side input terminals: 60 Hz AC, 3-phase, fused and provided by VFD manufacturer.
         1) Provide fast-acting semiconductor type, Class T, fuses, 200,000 AIC RMS.
   2. Inverter section:
      a. Pulse width modulated (PWM) voltage source inverter.
      b. Variable voltage and variable frequency using insulated gate bipolar transistors (IGBT).
   3. Convert section:
      a. Full wave diode bridge rectifier or SCR type rectifier.
      b. SCR type units shall not be phase controlled.
   4. DC bus linking converter and inverter.
   5. General requirement for variable frequency drives:
      a. Variable frequency in proportion to output speed.
      b. Variable output voltage with constant volts/Hz over a variable torque output range.
      c. Supply full rated current at frequency within a variable torque output range.
      d. Develop full shaft power needed.
   6. Verify variable frequency drives are checked against each motor's total amperage.
   7. Total harmonic distortion on voltage waveform: Not to exceed 5 % per IEEE 519 at point of common coupling.
   8. Drives shall have RFI/EMI filters.
   9. Minimum output frequency at full rated output amperage: 4 kHz.
   10. Drive to be seismic rated.
   11. The drive and bypass shall provide single-phase motor protection in both the VFD and bypass modes.

B. Variable Frequency Drives:
   1. Solid state, with a PWM output waveform.
      a. VVI, six-step, and current source drives are not acceptable.
      b. Enclosures:
         1) As a minimum, the following closure types are to be used unless noted otherwise on plans:
            a) General purpose such as locations within mechanical rooms: NEMA 1.
            b) Outdoors: NEMA 3R.

2) Use the following closure types where specifically indicated on plans:
   a) Dusty or corrosive atmospheres: NEMA 12 or better; sealed, non-ventilated, airtight.
   b) High ambient temperature environments: NEMA 12 enclosure with air conditioner option.
3) Enclosure, including accessories, to be completely assembled and tested or all components provided in a single factory supplied racking system with components and accessories assembled, wired and factory tested.

c. Employ full wave rectifier designed to prevent line notching.
   1) Drives 7.5 HP and greater:
      a) Provide AC line or DC bus reactors.
         (1) Minimum impedance: 5 % impedance.
   2) GTO's are not acceptable.
d. Drive efficiency: 97 % or greater at full speed and full load.
e. Displacement power factor: 0.98 at all speeds and loads.

2. Printed circuit boards:
   a. Tested and burned-in before assembly in completed variable frequency drive.
   b. Subject variable frequency drive to a preliminary functional test, eight hour burn-in, and computerized final test.
   c. Burn-in shall be at 104 DEGF, at full rated load, or cycled load.
   d. Drive input power: Continuously cycled for maximum stress and thermal variation.
3. Environmental operating conditions:
   a. 32 to 104 DEGF at 4kHz switching frequency.
   b. 0 to 3300 feet above sea level, less than 95 % relative humidity, non-condensing.
   c. Atmosphere: Standard equipment room environment.
4. Additional requirements:
   a. Provide same control interface and connections regardless of horsepower rating.
   b. On loss of input signal:
      1) Display a fault condition.
      2) Maintain last output speed prior to loss of signal.
   c. Utilize digital display (LCD or LED).
   d. Automatically restart after an overcurrent, overvoltage, under-voltage, loss of input signal protective trip or any other fault.
      1) Number of restart attempts and trial time to be programmable.
   e. Capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage.
   f. Provide an automatic extended power loss ride-through circuit which will utilize inertia of load to keep drive powered.
      1) Minimum power loss ride-through: One-cycle or extended time.
   g. Control terminal strip: Isolated from line and ground.
   h. Provide prewired 3-position Hand-Off-Auto switch, manual speed adjustment (keypad or potentiometer) and local-remote switch to control VFD.
      1) When in "Hand" position, VFD will be started.
      2) When in "Off" position, VFD will be stopped.
      3) When in "Auto" position, VFD will start via an external contact closure.
      4) When local-remote switch is in "Local" position, speed will be controlled by manual speed.
      5) When local-remote switch is in "Remote" position, speed will be controlled by external speed reference.
      6) Operate local-remote switch independently of HOA switch for maximum flexibility.
         a) Control speed by manual speed adjustment or external speed reference by selecting "Local" or "Remote" regardless of whether HOA is in "Hand" or "Auto" position.

5. Provide following adjustments:
   a. A minimum of 3 critical frequency lockout ranges to prevent variable frequency drive from continuously operating at an unstable speed.
      1) Width of each frequency range: Field adjustable.
   b. Two programmable analog inputs: Accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller.
      1) Minimum and maximum values (gain and offset): Adjustable within range of 0-20 mA and 0-10 Volts.
   c. Programmable analog outputs: Proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, or DC bus voltage.
   d. Relay outputs:
      1) Rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS.
   e. Independently adjustable accelerate and decelerate rates (1-600 seconds).
   f. Ramp or coast to a stop, as selected by user.
6. Operational information display will list the following as a minimum:
   a. Output Frequency.
   b. Motor current.
   c. Output voltage.
   d. Motor speed (RPM).
   e. kW meter.
7. Protection circuits: In case of a protective trip, stop drive and display fault condition.
   a. Overcurrent trip: 200 % of VFD's variable torque current rating.
   b. Overvoltage trip: 130 % of VFD's rated voltage.
   c. Undervoltage trip: 60 % of VFD's rated voltage.
   d. Overtemperature: Plus 158 DEGF.
   e. Adaptable electronic motor overload protection:
      1) Protect motor based on speed, load curve, and external fan parameter.
      2) Circuits which are not speed dependent are unacceptable.
8. Speed command input:
   a. Keypad or manual speed potentiometer.
   b. Analog inputs: Each capable of accepting a 0-20 mA 4-20 mA, 0-10 V, 2-10 V signal.
      a) Input: Isolated from ground, and programmable via keypad for different uses.
      b) Provide programmable filter to remove any oscillation of the reference signal.
      c) Able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed.
      d) Minimum and maximum values (gain and offset): Adjustable within range of 0-20 mA and 0-10 Volts.
   c. Pneumatic speed reference, 3-15 PSI: Via direct connection to adjustable frequency drive, without use of external pressure to electrical transducers.
      1) Provide a connector outside adjustable frequency drive enclosure for connection of pneumatic tubing.
9. Accessories:
   a. Interlock terminal strip:
      1) Provide separate terminal strip for connection of freeze, fire, smoke contacts, and external start command.
      2) External interlocks and start/stop contacts: Remain fully functional whether drive is in Hand, Auto or Bypass.
   b. All wires to be individually numbered at both ends for ease of troubleshooting.
   c. Door interlocked magnetic circuit breaker: Disconnect all input power from drive and all internally mounted options.
      1) Disconnect handle: Thru-the-door type, padlockable in "Off" position.

d. Manual transfer (bypass) to line power via three (3) contactors, electronic bypass is specifically not allowed.
   1) Include motor thermal overload and fuse or circuit breaker protection while in bypass operation.
   2) Provide a three position selector switch to control bypass drive input and output contactors.
      a) Electrically interlock bypass and drive output contactors.
   3) In "Normal" mode, bypass contactor is open while drive input and output contactors are closed.
   4) In "Test" position both bypass and output contactors are open.
   5) In "Bypass" position, drive input and output contactors are open, and bypass contactor is closed.
   6) Provide bypass feature where indicated on plans.

e. The VFD shall be supplied with RS-485 interface and integration card compatible with Building Management and Control System.
   1) Coordinate with Section 25 50 00.

f. All VFD's shall be fully integrated into the control system, and provided with communication in order for the DDC / BMCS to remotely command or monitor all applicable and relevant controls.
   1) Coordinate with Section 25 51 00.

C. Factory startup test:
   1. Provide a certified factory start-up for each drive by factory authorized service center.
      a. Certified start-up form: Filled out for each drive with a copy provided to Owner, and a copy kept on file at Manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions and as specified.

B. Install free standing units on 4 IN housekeeping pads.

C. Install wall mounted units to room walls, or on free standing pedestals.

D. Where VFD's are provided for air handling units, install within air handler integral cooled compartment. Coordinate with air handling unit manufacturer.

E. Cover and protect units from installation dust and contamination until environment is cleaned and ready for operation.

3.2 TESTING AND START UP

A. Field start up and testing:
   1. Provide services of a factory trained representative at site to supervise installation and startup.
   2. Test machines under operation through full speed range and record data at full load, 75 % load, 50 % load and 25 % load, for a minimum of 1 hour at each load.
   3. Field test according to ANSI Standards.
   4. Start-up tech shall ensure drives are clean, trouble free and lugs tightened and electrical connections torqued per manufacturers recommendations.

3.3 OWNER INSTRUCTIONS

A. Provide services of manufacturer's representative for 8 hours to instruct Owner's operating personnel.
   1. Instruction hours shall be in addition to testing and startup hours.

B. Schedule this period when equipment is completely installed and tested and can be operated under normal load.

C. Provide instruction on each system type.

END OF SECTION

SECTION 25 50 00
BUILDING MANAGEMENT AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Building Management and Control System (BMCS), as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

C. UCR Controls Systems Standards: Refer to Section 25 51 00.

1.2 DESCRIPTION

A. BMCS system shall be fully integrated through new operator workstation(s) and the existing operator workstation(s) with the existing Johnson Controls Metasys system in compliance with the performance requirements set forth in this specification. Equipment provided herein shall be required to communicate through a facility wide BMCS workstation by means of full binary interface to maintain operations for personnel. Include additional hardware and/or software required to maintain the integrity of the existing facility wide system. Hardware and software introduced as part of this project shall not alter integrity of existing facility wide control system.

B. Building Management and Control System (BMCS) incorporating Direct Digital Control (DDC), energy management and equipment monitoring consisting of the following elements:
1. Microprocessor based remote control panels interfacing directly with sensors, actuators, and environmental delivery systems to provide complete standalone DDC/EMS functionality. (i.e., HVAC equipment, etc.).
2. Communication network to allow data exchange between remote panels and central building management computer.
3. Personal computer (PC) based central and associated operator station(s), and software functioning as the primary operator interface for BMCS. System shall utilize a graphics front end.
4. Pneumatic, electric and electronic control for all items indicated including dampers, valves, panels and pneumatic and electrical installation.

C. Air terminal unit damper operators and controls: Provide DDC controllers and actuators under this Section.

D. Room pressure monitoring controls: Provide controls under this Section.

E. Smoke and fire/smoke dampers and operators are provided under Section 23 31 13. Power connection to smoke and fire/smoke dampers shall be provided under Electrical Specification Divisions. Damper end switches shall be provided and wired under this Section.

F. Control dampers: Control dampers less actuators are provided under Section 23 31 13. Provide actuators for control dampers under this Section.

G. Duct mounted smoke detectors are to be furnished and wired under Electrical Specification Divisions. The detectors shall be mounted in compliance with Section 23 31 13.

H. Provide submittals, installation, data entry, programming, startup, test and validation of BMCS, instruction of Owner's representative on maintenance and operation of BMCS, as-built documentation, and system warranty.

1.3 QUALITY ASSURANCE

A. System installed by mechanics with responsibility for operation of BMCS, including debugging and calibration of each component in system.

B. Codes and Approvals:
   1. Complete BMCS installation to be in strict accordance with national and local electrical codes, and Electrical Specification Divisions of these specifications. All devices designed for or used in line voltage applications to be UL listed.
   2. Microprocessor based remote devices: UL916 and UL864 listed.
   3. BMCS central equipment: UL916 listed.
   4. Electrical environmental control and monitoring devices: UL429 and/or UL873 listed.
   5. Electronic equipment: Label and comply with requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference for Class A computing devices.
   6. UL standards:
      a. UL429 Electrically Operated Valves.
      b. UL555 Fire Dampers.
      c. UL873 Temperature Indicating and Regulating Equipment.
      d. UL916 Energy Management Equipment.
   7. NFPA Standards and Guides:
      a. NFPA-70 National Electric Code.
      b. NFPA-90A Air Conditioning Systems.
      c. NFPA-90B Warm Air Heating, Air Conditioning.

C. System Components:
   1. Fault tolerant.
   2. Provide satisfactory operation without damage at 110 % and 85 % of rated voltage, and at ± 3 hertz variation in line frequency.
   3. Provide static, transient, short circuit, and surge protection on all inputs and outputs. Communication lines to be protected against incorrect wiring, static transients, and induced magnetic interference. Bus connected devices to be a.c. coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.
   4. All real time clocks and data file RAM to be battery or capacitor backed.

D. System Overall Reliability Requirement:
   1. Configure system and install to yield a Mean Time Between Failure (MTBF) at least 1000 hours.

E. System Accuracy and Display:
   1. Maintain system end-to-end accuracy for 1 year from sensor to Operator's console display for applications specified and shall display value as specified.

F. Rate field equipment for continuous operation under ambient environmental conditions of 35 to 120 °F dry bulb and 10 to 95 % relative humidity, non-condensing.
   1. Rate instrumentation and control elements for continuous operation under ambient environmental temperature, pressure, humidity and vibration conditions specified or normally encountered for installed location.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Complete system design information including:
      a. Data entry forms for initial parameters. All text and graphics to be approved prior to data entry.
      b. Valve, and damper schedules showing:
         1) Size.
         2) Configuration.

3) Capacity.
4) Location.

c. Wiring and piping interconnection diagrams, including panel and device power and sources.
d. Equipment lists (bill of materials) of all proposed devices and equipment.
e. Software design data including:
1) Flow chart of each DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc.
2) Sequence of operation relating to all flow chart functions.
f. Control sequence.
g. DDC installation, block diagrams, and wiring diagrams for each piece of equipment.
h. DDC panel physical layout and schematics.
i. Building level overview of control system architecture.

B. Product Data:
1. Complete list of product data including:
a. Data sheets of all products.
b. Valve, damper, and well and tap schedules showing size, configuration, capacity, and location of all equipment.

C. Project Information:
1. Certification of installer qualifications.

D. Contract Closeout Information:
1. Operation and Maintenance Data:
2. As Built Instrumentation and Control Diagrams at 1/8 IN scale showing:
a. Communication cable circuiting drawing with DDC panels and communication devices labeled.
b. Power wiring circuiting drawing showing 120 volt circuit source and low voltage transformer locations, identifications, and circuit roués to each controlled device per transformer for the DDC system.
3. Owner instruction report:
a. Certification that Owner Training has been provided by BMCS installer.

1.5 TECHNICAL SUBMITTAL REQUIREMENTS

A. Technical Proposal: A detailed technical proposal shall be provided and formatted strictly in accordance to this outline. A copy of the proposal shall be forwarded to the Contractor and Engineer. A paragraph by paragraph compliance sheet indicating conformance to, or exception to the specific specification section, including sequence of operations Reason for exception and alternate solutions shall be indicated.
1. Proposed system complete with location and block diagram including central computer type and memory, peripherals, communication interfaces, all LAN cards, all active hubs and repeaters, network layout, distributed peer bus connected control/monitor and listing of equipment directly connected to a peer bus controller and secondary network drivers and connected systems. Also identify on each panel the number of unused I/O slots.
2. Computer based central:
a. Day-to-day interactive operator interface description with sample Graphic displays penetration scheme for display/command and logical configuring, and examples of alarms and data in various modes (disabled, fixed, not responding, etc.).
b. Report descriptions and trend logs including selection scheme and sample reports.
c. Programming facility including language and canned packages of subroutines and intrinsic functions.
d. Sample sequence of operation and flowchart display.
e. Sample custom report.
f. Sample text alarm message.
g. Sample of system and point descriptor text.

h. Technical description of all hardware components.
i. Colorgraphic system description with sample system displays, colorgraphic penetration and command schemes, graphic creation means, library of symbols, curve plot.

3. Distributed control panel point architecture, memory, battery.
   a. Functional description of all remote panels.
   b. Scan/Report speed and alarm detection speed.
   c. Control and survival capabilities.
4. Communications network architecture, points, panels.
   a. Protocol description, host independent, bus-cut reaction.
   b. Bus limitations, distances between active links and hubs, etc.
   c. Error checking, collision prevention, recovery.
   d. Point sharing/update scheme.
   e. Meantime end-to-end responsiveness for a large fully operational system for analog alarm report, digital alarm report, panel failure report, host command execution, event command (within one panel and panel-to-panel).
5. Available services for full system maintenance, software update and modifications, hardware spare parts, adds and changes, system training and training classes.
6. Installer experience/capability, size.
   a. Organization with resumes of project manager, project engineer, installation supervisor and pipefitter foreman.
   b. History of local support of management, engineering, installation, and maintenance locations and business.
   c. Local experience on similar jobs with references.
   d. Local facility description.
   e. History of automation/management system evaluation and ongoing support.
   f. Project organization- include resumes. Mandatory Minimum requirements.
7. On-site Project Manager, Project Engineer, Installation Supervisor and Pipefitter Foreman.
8. Vendors' standard specification data literature.

1.6 WARRANTY

A. All components, system software, parts, and assemblies supplied by BMCS manufacturer to be guaranteed against defects in materials and workmanship for one year from acceptance date.

B. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by BMCS installer at no charge to Owner during warranty period.

C. All corrective software modifications made during warranty service periods to be updated on all user documentation and on user and manufacturer archived software disks.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Temperature Control System:
   1. Base:
      a. Johnson Controls.
   2. Optional:
      a. Automated Logic Corporation.

B. Room Pressure Monitoring Controls:
   1. Base:
      a. Tek Air.
   2. Optional:
      a. Air Monitor.
      b. Or equal.

C. Air Flow Monitoring Stations:
   1. Base:
      a. Ebtron.
   2. Optional:
      a. Air Monitor.
      b. Tek Air.
      c. Paragon.
      d. Or equal.

D. Steam and Chilled/Heating Water Flow Meters:
   1. Base:
      a. Onicon.
   2. Optional:
      a. Rosemont.
      b. Emco.
      c. Or equal.

E. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Temperature Control System:
   1. Include:
      a. Temperature sensors.
      b. Humidity sensors.
      c. Controllers.
      d. Switches.
      e. Relays.
      f. Valves.
      g. Dampers.
      h. Damper operators.
      i. Thermostats.
      j. Humidistats.
      k. Hygrometers.
      l. Other associated controls required to maintain conditions described on drawings, together with thermometers, gauges and other accessory equipment.
   2. Provide complete system of wiring and air piping as necessary to fill intent of these specifications.
   3. Control sequences indicated illustrate basic control functions only.
   4. Provide additional controls required to meet intent of these specifications and make a complete system.

B. Where electronic sensing is used, furnish amplifier relays and transformer complete with overload protection.

C. Electrical drawings indicate type of motor control required by equipment.

2.3 PORTABLE OPERATOR'S TERMINALS

A. Portable Operator's Terminal (POT) for operator readout of system variables, override control, and adjustment of control parameters. Hand held, plug-compatible with Network Control Processors (NCP), Local Control Processors (LCP), and LCP space thermostats. Provide 1 unit.

B. Functionality:
   1. Automatically display a sequential all point summary.
   2. Allow display and/or changing of digital point state, analog point value, time and date, application and DDC parameters, analog limits, time schedules, run time counts and limits, daylight savings time changeover, time/event initiation, and programmable offset values.

3. Allow access to initialization routines and diagnostics, and enable/disable of points, initiators and programs.

C. Complete with command keys, data entry keys, cursor control keys, and liquid crystal alpha-numeric display. Access via self prompting menu selection with next menu/previous menu, and step forward/step backward within given menu. Connection of POT to panel to not interrupt, or interfere with normal network operation.

D. Provide access to all LCPs on respective bus. Displays to provide text via 64 character minimum screen with English descriptors.

E. As an alternative to the POT's, a laptop computer with browser software to execute the above mentioned functions or fixed liquid crystal displays and entry keyboards may be provided. Functional capability must be equal to that described for the POT as a minimum. The fixed display and keyboard must be under lock and key control to prevent tampering.

2.4 NETWORK SYSTEM

A. Remote Panel Hardware:
1. General:
   a. Network control panels (NCPs) serving AHUs, etc., and local control panels (LCPs) serving air terminal units, unit heaters, etc., shall be compatible with BMCS system communication protocol.
   b. Microprocessor based remote panels with EPROM operating system (OS), and minimum 10 MHz operating speed. DDC programs and data files shall be in EPROM with RAM image to allow simple additions and changes. All EPROM socketed for easy replacement.
   c. EPROM/RAM DDC programs and data files to provide for instant loop recovery upon power restoration after outage beyond that which is power backed. Provide power backup of 4-hour instant recharge capacitor, or 12-hour trickle recharged batteries. RAM images, including all user additions, and changes to be up/down line loadable to central disk for backup.
   d. RAM DDC programs and data files without EPROM backup provided with 72 hours of battery backup complete with automatic monitoring, and "replace battery" alarm messaging. Upon power restoration after outage beyond that which is power or EPROM backed, all RAM to be automatically downloaded and remote panel automatically reinitialized. Systems without EEPROM or EPROM default programs shall provide automatic daily diagnostic and verification routines with historical logging and retrieval to assure that RAM based programs do not become altered or corrupted. Complete automatic download of all RAM shall occur within one hour after power restoration and battery loss.
   e. All backup power to support clocks. Clocks to be automatically synchronized upon system recovery.
   f. The panels serving air handling units, central chiller plant, and central boiler plant shall have integral LCD display and key pad, which will allow all points to be viewed and adjusted at the panel. Panel shall have ability to display software alarms and to automatically scan all inputs/outputs with rotating display.
2. Real time clock to have one hundred year calendar with automatic leap year. Provide time of day, day of week, and date.
3. Remote panels provided with capacity to accommodate maximum of 64 input/output (I/O) points. Remote panels configured with analog and digital inputs and outputs, and pulse counting totalizers as required for application, such that primary input, output, and all control logic is resident in single microprocessor for network independent standalone closed loop DDC. Provide socket for portable operator's terminal(POT).
4. Panel inputs selected for application utilizing sensor types specified.
5. Remote panel outputs to be digital for discrete control, or true variable voltage/variable current outputs for driving analog pneumatic transducers. Analog outputs with minimum

incremental resolution of 1 % of operating range of controlled device. Output points to have manual HOA switches on control panel.

a. NCPs: Sixteen bit microprocessors for DDC and energy management applications, peer-to-peer communications with other NCPs and host computer, and coordination and data concentration for subnetwork of up to 150 LCPs.
b. NCP configuration restrictions:
   1) Each air handling unit shall be on a separate controller.
   2) All points for individual air handler or other major system functions shall be served from the same master panel.
   3) Each DDC panel shall have a minimum of 10% of its I/O functions as spare capacity. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall be less than two spare points of each implemented I/O type.
c. LCPs: Eight bit microprocessors with minimum clock speed of 20 MHz for DDC and terminal unit control applications, and subnetwork communications. Triac/Tristate outputs are allowed only on air terminal unit controllers. Use of triac/tristate outputs on central systems such as AHU's is not acceptable.

6. Panel electronics installed in finished steel enclosures. Equipment room panels with hinged doors containing all load relays, transducers, and associated equipment.

B. Data Communications:
1. General:
   a. All air handling unit, roof top unit, exhaust fans, central chiller plant, and central boiler plant NCPs and operator work stations shall be interconnected with a LonMark or BACnet communications network. Network must pass LonMark product performance review. All devices must be configured identically. Minimum operating speed of LonMark communications network shall be 78000 baud. The terms "central chiller plant" and "central boiler plant" refer to chillers, boilers, cooling towers, associated pumps, variable speed drives, differential pressure sensors for variable speed pumping systems, heat exchangers, fans, mechanical room equipment, etc.
   b. The use of a proprietary communications network (ex. All LCPs interconnected via secondary networks managed by NCPs) with a two-way gateway between the panel network and the LONTALK or BACnet network must be transparent to the system operator and approved by the engineer prior to bid. Proprietary network, if used, shall be as described below.
   c. The communications network shall be capable of integrating information from existing control systems. The intent is that all facility operations new or existing would be shown on one system operator work station and operation would be transparent to the operator.
      1) Optional manufacturer's ability or inability to interface with the existing system shall be clearly addressed in the Technical Proposal.
2. All NCPs interconnected via primary peer-to-peer communications network. LCPs also connected together via secondary networks managed by NCPs. All communications to be via twisted pair wires. DDC microprocessor failures shall not cause loss of communications of the remainder of any network. All networks to support sensor sharing, global application programs, and bus-to-bus communications without the presence of host PC.
   a. NCPs capable of transmitting message to any other NCP.
   b. Messages transmitted to be positively acknowledged as received, or negatively acknowledged as not received. Negative acknowledgements require retransmission of message.
   c. Bus connected devices with no messages to transmit must send "I'm Ok" (or similar) message each bus cycle.
   d. Full communications sustained with as few as two operational devices on any segment of bus.

e. Each NCP provided with communications watchdog to assure that an individual NCP cannot permanently occupy bus.
f. All messages to contain CRC 16 bit checkword.
g. Error recovery and communication initialization routines resident in each bus connected device.
h. Multi bus communications capability provided allowing exchange of data, and execution of programs across individual peer buses.
i. Editing and overriding local stand-alone panel programs shall be possible remotely via modem.

3. NCP communications network to support true peer protocol so each NCP has equal rights for data transfer, and report in its predetermined time slot. Each device on bus to be capable of taking over function of bus monitor to assure that loss of any single device (controller, workstation or network server) will not cause total bus failure.
4. LCPs to be managed by NCPs via active network to provide:
   a. Alarm detection and reporting.
   b. Response to operator station data requests and commands.
   c. POT communications from LCP to any other networked LCP, and from NCP to any connected LCP.
   d. LCP program loading.

C. Operator Station Software:
1. The system shall have software completely compatible with the existing software. This includes but is not limited to control programs, DDC control algorithms, trending, graphics, system security, and reporting.
2. General: Operator station software to include as minimum Operating System (OS), Data Base Manager, Communications Control, Operator Interface (OI), Trend and History Files, Report Generator, Support Utilities, Scheduler, and Time and Event Programs.
   a. Real time operating system to provide true multitasking providing concurrent execution of multiple real time programs, and custom program development.
   b. Data Base Manager to manage all data on integrated and non-redundant basis. Allow additions and deletions to data base without any detriment to existing data. Cross linkages are to be provided such that no data required by software program may be deleted by operator until that data has been deleted from its respective program.
   c. Communications control, scheduler, trend files, reports, operator interface, and utilities as specified.
3. Operator interface software: Provide hierarchical linked dynamic graphic operator interface for accessing and displaying system data, and commanding and modifying equipment operation. Interface to utilize mouse to provide "heads up operation, with pull down menus, dialog boxed, zoom coloration and animation to facilitate operator understanding of system. Minimum of twenty levels of graphic penetration provided. Descriptors for graphics, points, alarms, etc. modifiable through operators station under password control.
   a. Operator access to system to be under personal ID and password control. Up to 12 alphanumeric characters for personal ID, and up to 12 alphanumeric characters for password to be assignable to each operator via operator station. Operator to be able to access system from any operator station in system by entry of proper ID and password. Operators shall be permitted to change their own password without permitting access to any other password. Sign-off from station to be manual operation via pull-down menu, or if no mouse or keyboard activity takes place within assignable time period, shall be automatic. Automatic sign-off period selectable from ten minutes to 120 minutes for each operator or disabled on per operator basis. All sign-on/sign-off activity to be automatically archived on operator station for display or printout as desired.
   b. Operator access to system points controlled by individual operator-assigned hierarchy. For example, operator may have access to one building, but not to another building. Each operator to have any combination of user assigned keyboard privileges of alarm

acknowledgement, point commanding, data modification, DOS access, schedule changes, and system configuration changes.

c. Data displayed to be assignable regardless of physical hardware address, communication channel, or point type (temperature, humidity, fire alarm, etc.) Screens to be on-line programmable, and under ID and password control. Points may be assignable to multiple screens (10 minimum), where necessary to facilitate operator understanding of system operation. Screens to contain calculated or pseudo points. Each physical point and each point assigned to screen to be assigned English descriptor for use in reports.

d. Data segregation to be provided for control of specific data routed to operator station, to operator assigned to station, or to a given output device such as printer. Point classes to be randomly selectable such as all temperature points, temperature points second floor, HVAC points, command points, etc. Display and/or output of data to printer or color monitor shall occur where there is match of operator, or peripheral segregation group assignment, and point segregations. Operators and peripherals shall be assignable, and all assignments are to be on-line programmable and under password control.

e. Penetration within graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding. "Backtrace" shall permit operator to move upward in hierarchy by mouse click on backtrace. Backtrace shall show at least previous four penetration levels. Operator shall be provided option of showing each graphic full screen size with backtrace as horizontal header, or by showing "stack" of graphics, each with backtrace.

f. All operator accessed data shall be displayed on color monitor. Select further penetration via mouse click on area, building, floor, fan, etc. Defined linked graphic below that selection shall then be displayed. Dynamic data assignable to any and all graphics. Provide means to directly access any graphic without going through penetration path.

g. Points (physical and pseudo) to be displayed with dynamic data provided by system with appropriate text descriptors, status or value, and engineering unit. Coloration to be used to denote status and alarm states. Coloration conventions to be variable for each class of points. All points shall be dynamic with update rates user adjustable on per point basis, depending upon process dynamics.

h. For operators with appropriate privilege(s), points shall be commanded directly from color monitor via mouse selection. For digital command point such as valve position, valve would show its current state (e.g., CLOSED), and operator could select OPEN via mouse click. For most operations, keyboard equivalent shall be available for those operators with that preference.
   1) Upon selection of analog commandable points (such as discharge air static pressure), dialog box to appear containing following:
      a) Value of selected point as decimal value, and as represented on scaled bar chart element.
      b) Scaled setpoint arrow pointing to current position of setpoint value on bar chart.
      c) Decimal value of setpoint with adjacent up-down arrows.
   2) Provide three methods of analog commanding from which to choose as follows:
      a) Click cursor on decimal setpoint value, and enter new setpoint value via keyboard decimal keypad.
      b) Drive decimal value up or down via up-down arrows.
      c) "Drag" setpoint arrow up or down by moving cursor to desired position and clicking.
   3) Chart to have associated arrows showing current position (scaled value) of alarm limits.

i. Provide splitting or resizing viewing screen to show one data set on left half of screen and another data set, spreadsheet, bar chart, sequence of operation, curve plot, etc., on

right half screen to allow real time monitoring of one part of system, while displaying other parts of system or data from system to facilitate system operation.

j. Provide on-line context-sensitive help utility to facilitate operator training and understanding. Help feature to be hypertext document with ability to bridge to further explanation of selected keywords. Document to contain text and graphics to clarify system operation. At minimum, help shall be available for every menu item and dialog box.

k. Electronic messaging facility to be provided on operator station for any operator to enter message to another operator by selecting MAIL menu item, selecting receiving operator's ID, and entering message (such as "CLEAN PRE-HEAT STRAINER ON AHU-2"). When operator with queued message signs onto operator station, "Mail Message" area of dialog box shall indicate that message is waiting. Upon selecting mail display, operator shall be presented index of title or subject of each from which operator may select order of display. Upon displaying mail message, display shall prompt operator with three message options to execute: delete, print, and save. Messages shall also include time and date message was sent, sender's personal ID, and be 300 characters minimum length, plus brief title of subject description.

4. Site specific customizing software:

a. Provide software to allow user to modify and tailor BMCS to specific and unique requirements of equipment installed, programs implemented, and to staffing and operational practices. Online modification of system configuration, program parameters, and data base to be provided via menu selection and keyboard entry of data into preformatted self-prompting templates. As minimum, following modification capability shall be provided:

1) Operator assignment capability to include designation of operator passwords, privilege(s), starting graphic, and auto sign off duration.

2) Peripheral assignment capability to include assignment of segregation groups to consoles and printers, designation of backup consoles, and printer.

3) System configuration/diagnostic capability to include communications and peripheral port assignments, NCP assignments to communications network, NCP enable/disable, assignment of command trace to points, and initiation of diagnostics.

4) System text add/change capability to include action messages for alarms and run time, and trouble condition messages.

5) Time/schedule change capability to include time/date set, time/occupancy schedules, holiday schedules, daylight savings time schedules, and activity defined schedules. Operators with appropriate privilege shall be capable of naming an activity, which requires associated equipment to support activity. Named activity shall be assigned such associations and subsequently, activity can be scheduled by operator with underlying associated equipment automatically provided identical schedule by BMCS.

6) Points uniquely definable as to coloration, audible rate and duration, point descriptors (60 characters minimum), operator messages (480 characters minimum), printer options, alarm archival option, alarm and warning limits, and engineering units.

7) Point related change capability to include system/point enable/disable; run time enable/disable; assignment of points to point classes, analog value offset, lockout, run time limits, and setting fixed input or output value.

8) Application program change capability to include enable/disable of EMS programs, EMS program parameter changes, assignment of comfort limits, global points, time and event initiators, time and event schedules, and enable/disable time and event programs.

9) Totalization capability to sum event occurrence, run time, chilled water/tonage usage, steam usage, electrical usage etc.

b. Provide software to allow user to add points or groups of points to system, and to link them to control programs. All additions and modifications are to be online programmable via operator station, downline loaded to NCPs, and entered into their data bases. After verification of point additions and associated program operation, data base shall be upline loaded and recorded on hard disk for subsequent reinitialization download.

c. Provide Pascal or other high level language programming capability for implementation of custom DDC programs. Software to include compiler, linker, and upline/download capability. In addition, library of DDC algorithms, intrinsic control operators, logic operators, and relational operators for implementation of control sequence shall be provided and included as minimum:

1) Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self learning). Adaptive Control algorithm shall be used on control loops, as indicated in Data and Control summary, where controlled medium flow rate is variable. Adaptive control algorithm shall monitor loop response to output corrections, and adjust loop response characteristics in accordance with time constant changes imposed by variable flow rates. Algorithm shall operate in a continuous self learning manner, and retain in memory stored record of system dynamics so that on system shutdown and restart, learning process starts where it left off.

2) Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select, lowest select, analog controlled digital output, analog control analog output, digitally controlled analog output.

3) Logic and relational operators (AND, OR, NOT; EQUAL TO, NOT EQUAL TO, LESS THAN ...; etc.), which are standard set available with Pascal or other similar high level language.

5. Provide alarm handler software to respond to alarm conditions sensed and transmitted from NCPs and LCPs. First in, first out handling of alarms in accordance with alarm priority ranking is required with buffer storage for minimum of 20 alarms in case of simultaneous multiple alarms. Alarm handler shall be active in both Signed On and Signed Off modes to assure that alarms will be processed even through operator is not currently signed on.

a. Display alarms in dialog box of color monitor includes as minimum:

1) Indication of alarm condition; i.e. ABNORMAL OFF, HI ALARM/LOW ALARM, analog value or status, and English group and point identification such as “SPACE TEMPERATURE SURGERY ROOM 2.”

2) Discrete per point alarm action taking message; i.e. "The fan has shutdown due to an excessively high discharge duct pressure. There is a strong indication of a system malfunction such as an inlet vane drive failure, or major fire damper closure. The switch should not be manually reset until a thorough investigation of the cause is conducted" of up to 480 characters.

b. Direct alarm to appropriate operators, operator stations, pagers, and printers for segregation assignments.

c. Alarm silencing to be by selecting "silence" button, or by authorized operator's acknowledgement. In all cases, alarm acknowledgement shall only be allowed by operators authorized to acknowledge point in alarm.

d. Each point to be assigned to alarm class, with no limit to quantity of alarm classes. Each alarm class uniquely assignable to any combination of following alarm processing attributes:

1) Audible beep duration (none, 10 seconds, 20 seconds, continuous).

2) Audible beep rate (slow-medium-fast).

3) Alarm historically archived (yes or no).

4) Alarm printed, with printer ID.

5) Associated coloration with any of 256 colors, with separate brightness control, assignable to each alarm state (high alarm, high warning, normal, low warning, low

alarm). Digital points shall similarly be distinguished with different colors for each possible state.

e. Alarms to be displayed and/or printed at each peripheral to which its segregation allows, but only those operators having proper privilege level will be allowed to acknowledge alarms.
f. Unacknowledged alarm indicator to be provided on color monitor display to alert operator that there are unacknowledged alarms in system.
g. Points in graphic display that are in unacknowledged alarm state to have flashing red border; when in acknowledged state, border shall be non-flashing red.
h. Run time limit messages to be presented and processed as alarm messages, except action message shall be of maintenance directive nature.

6. Standard reports to be provided, which shall be operator selectable to appear on operator station, any selected printer or both. All facility wide standard reports shall be capable of being scheduled to run at specific time, and/or interval via operator function supported by necessary data entry templates and interactive prompts. "Terminate report" command shall be available to allow operator to stop any report in process of being printed. Standard pre-formatted reports to be provided to include:
   a. Point summary reports may be requested at any penetration level (facility, building, area, system), and shall include only points at and below that level. Point summary reports to include current value/status and condition, English system, and point descriptors for all points. Point summary reports to be selectable for all points, only those points in alarm, fixed points, disabled points, and locked out points.
   b. Trend reports to allow operator to randomly select logical arrays of points to be recorded at selectable time intervals. It shall be possible to assign up to ten variables to each trend report. Format, headers, footers, and calculations shall be selectable by operator. Trend report stored to disk and subsequently capable of being displayed, and/or printed by operator.
   c. Dynamic trends to provide up to six points, and show real time activity of associated points. This information to be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by operator. Graphic plots to allow unique color for each point. As new point values are sampled, they shall be processed, scaled, and dynamically appended to any plot being displayed.
   d. Alarm and run time reports to be automatically issued to assigned printers immediately upon occurrence, and shall consist of point descriptor, status or value of point with engineering unit, time and date, and action taking alarm message.
   e. User to be provided with command trace feature selectable on per point basis, allowing archiving of all commands issued to each point. Archived trace shall include command, command source, point ID, and time and date. Command trace reports to be output upon operator demand.
   f. Custom report capability to be provided to allow user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports may be scheduled or requested manually. Spreadsheet program similar to Microsoft Excel shall be provided fully integrated with BMCS data base, and available to user. In event of failure of any printer, subsequent reports directed to that printer shall be automatically redirected to operator preassigned backup printer located at operator station.
7. Text screen creation: Provide on-line text screen development facility to allow user to develop or modify text screen displays, and assign and position any array of points within each screen.
   a. All screen displays to be on-line created via operator station software package. It shall not require taking operator station off-line, or interfere with point archiving and alarms.
8. Graphic creation: Provide on line graphic development facility to allow user to develop or modify graphic displays and assign and position any array of points within each graphic.
   a. All graphic displays to be on line created via operator station graphics package. It shall not require taking operator station off-line, or interfere with point archiving and alarms.

Graphics created via mouse and keyboard selection of graphic library stored symbols and system profiles. Provide in profiles capability to create custom symbols, system profiles floor plans, buildings, etc. and to store them in graphic library.

9. Digital system management: Operation station to provide complete utilities necessary for management of network of digital controllers and devices.
   a. Any RAM based digital device may be up-line, or down-line loaded to or from operator station disk for backup archival.
   b. Provide software to execute and observe diagnostics of any remote device connected to peer bus, and ability to deactivate and restart device.
   c. Operator to be provided with ability to override use of portable operator's terminal on any remote NCP.
   d. (Provide additional feature under alternate bid) Provide multi-page set of graphic architectural displays showing each digital module, including each remote panel, PC, peripheral, and communication links. Clicking on any device shall start interactive dialog allowing user to observe device status, and to select device management options. Each device shall also be provided with English descriptor of up to 60 characters.
10. Operator station utilities: Operator station personal computer shall be provided with following system utilities, or desktop application packages:
   a. Clock: Real time clock.
   b. Calculator: Basic arithmetic calculation functions (add, subtract, multiply, divide, percent, square root).
   c. Clipboard: Data transfer facility between dissimilar programs.
   d. Calendar: Electronic appointment calendar.
   e. Cardfile: Electronic index card file.
   f. Control panel: Basic PC operating characteristic control: cursor blink rate, mouse sensitivity, screen color control, etc.
   g. Write: Word processing program.
11. System must be capable of running standard off-the-shelf MS DOS IBM PC compatible software packages concurrently with real time system. Fully tested and qualified integrated third party software package including spreadsheet, data base manager and word processing, and capable of running under MS DOS is to be identified as system compatible.
   a. Base system software shall include CRT "windowing" feature to allow operator to monitor real time system, and use third party software simultaneously.
   b. All third party software packages identified shall have access to system historical data base previously specified.

D. Remote Panel Software:
1. General:
   a. Remote panels (NCP, LCP) shall operate totally standalone, and independent of central computer for all specified control applications. Software to include complete operating system (OS), communications handler, point processing, alarm processing, standard control algorithms and specific control sequences (DDC), and owner/user custom control and calculation package complete with interpreter. (Reference "Data Communications" for communications network requirements).
   b. OS software shall be EPROM resident, operate in real time, provide prioritized task scheduling, control time programs, monitor and manage panel to panel and panel to central computer communications, and scan inputs and outputs. OS to contain built-in diagnostics.
   c. Input/output point processing for each panel to include:
      1) Continuous update of input and output values and conditions. All connected points are to be updated at minimum of one second intervals.
      2) Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32 bit floating point format.

3) Assignment of proper engineering units, and status condition identifiers to all analog and digital input and outputs.
4) In addition to physical points specified and listed, "Pseudo" software points to be provided where required for displayable and addressable command access, and meaningful displays. All pseudo points shall be derived in remote control processor for timely display.
   a) Pseudo points to appear identical to physical points in displays and graphics, and shall be assignable to text descriptors, logical groups, reports, etc., in same manner as physical points.
   b) Analog pseudo points which are result of calculation (GPM, tons, etc.), to be processed, and assignable alarm limits exactly like physical points.
   c) Each PID setpoint and other program values specified to be displayable and commandable, and shall be assigned upper and lower command limits beyond which point cannot be easily commanded. Command limits to be Owner adjustable via restricted codes.

d. Command control software to manage receipt of commands from central operator's console, portable operator's terminal, and from control programs.
   1) Command delay, programmable from 0 to 30 seconds, provided to prevent simultaneous energizing of large loads.
   2) Each command to be assigned command and residual priority to manage contentions created by multiple programs having access to same command point. Only commands with higher command priority than existing residual priority shall be permitted to execute. Whenever command is allowed to execute, its assigned residual priority shall replace existing residual priority.
   3) "Fixed mode" option to be supported to allow inputs to and outputs from, DDC control programs to be set to fixed state or value. When in "fixed mode", inputs and outputs are to be so noted in all reports.
   4) Last user record is to be maintained to positively identify which program or manual command is in control of given point. Last user information shall be displayed, and printed along with other point data of logical groups.

e. Alarm processing:
   1) Analog input alarm comparison with ability to assign two individual sets of high and low limits (warning and actual alarm), to input or to assign set of floating limits (as defined below) to input to be provided. Each alarm to be assigned unique differential to prevent point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
   2) Where analog controlled values are automatically varied by software (such as hot water temperature reset), single set of alarm limits to be provided for those varying values, which "float" a user definable differential above and below varying set point value.
   3) Provide debounce of digital inputs to prevent nuisance alarms. Each point debounce timing adjustable from two seconds to two minutes in one second increments.
   4) Alarm lockout provided to positively lockout alarms when equipment is turned off, or when true alarm is dependent on condition of associated point. Lockout points and lockout initiators to be operator programmable. On initial startup of air handler and other mechanical equipment, "timed lockout" period to be assigned to analog points to allow them to reach stable condition before activating alarm comparison logic. Lockout period programmable on per point basis from 0 to 90 minutes in one minute increments.
   5) Run time to accumulate on status of digital input points. Totalize either on time or off time up to 10,000 hours with one minute resolution. Run time counts to be resident in non-volatile memory, and have NCP resident run time limits assignable through operator's terminal. When run time limits are reached, NCP shall issue report to operator stations.

6) Provide transition counter to accumulate number of times device has been cycled on or off. Counter to be non-volatile, capable of accumulating 600,000 switching cycles. Limits assignable to counts to provide maintenance alarm printouts.

f. Provide custom DDC program to meet control strategies as called for in sequence of operation. Each remote panel to have resident in its memory, and available to programs full library of DDC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences.
   1) All DDC setpoints, gains, parameters, and time constants associated with DDC programs to be available to operator for display and modification via central operator interface, and/or portable operator's terminal.
   2) Execution interval of each DDC loop to be adjustable from two to 30 seconds.

g. Occupancy/time programs to include up to two independent start and stop times per day for each system.
   1) Provide unique time programs for each day of week, plus unique holiday schedule. Each motor may be provided with unique time programs, or motors may be grouped and assigned to common time program.

h. Provide time and event programming (TEP) capability, which will initiate sequence of commands for execution at specific time or upon occurrence of event. Program features required as minimum are:
   1) Analog points to be commandable to specific value.
   2) Digital points commandable to specific state; i.e. on or off; fast, slow or off.
   3) Initiator to be specific day and time or specific event; i.e. either analog or digital alarm occurrence.
   4) Commands must honor command delays and residual priority structures.
   5) Multiple commands assigned to single initiator and ability to chain TEPs.
   6) Ability to enable and disable TEPs, and initiators individually and manual initiation.

2.5 WEB BASED SYSTEM

A. BMCS Architecture:
   1. Overall Conceptual Description:
      a. The BMCS shall be designed entirely for use on intranets and internets. All networking technology used at the Tier 1 level shall be off the shelf, industry standard technology fully compatible with other owner provided networks in the facility.
      b. All aspects of the user interface, whether to servers or to Tier 1 solid state devices, shall be via browsers. Any PCs used as operator interface points shall not require the purchase of any special software from the manufacturer in order to provide the complete user interface as described herein.
      c. The user interface will be complete as described herein, providing complete tool sets, operational features, multi- panel displays, and other display features. Systems which merely provide HTML based web pages as the operator interface will not be acceptable.
      d. The primary components of the system will be the Primary Application Nodes and Servers located at the highest level of the network architecture. Both will use the same user interface and provide the same level of accessibility via the network. The only distinction between the user interface used on servers as compared to Primary Application Nodes will be select menu items used for accessing long term storage features on the servers or on their respective archive devices (CD/RW, etc.)
   2. General:
      a. The BMCS shall consist of a number of Nodes and associated equipment connected by industry standard network practices. All communication between Nodes shall be by digital means only.
      b. The BMCS network shall at minimum comprise of the following:
         1) Operator PCs – fixed or portable.

2) Network processing, data storage and communication equipment including file servers.
3) Routers, bridges, switches, hubs, modems and like communications equipment.
4) Active processing Nodes including field panels.
5) Intelligent and addressable elements and end devices.
6) Third-party equipment interfaces.
7) Other components required for a complete and working BMCS.

c. All BMCS features shall be accessible via Enterprise Intranet and Internet browser with equivalent BMCS access control for user access.
d. The BMCS shall support auto-dial/auto-answer communications to allow BMCS Nodes to communicate with other remote BMCS Nodes via standard telephone lines. Refer to drawings for type of line to be used, DSL or voice grade. Where no preference is indicated, DSL is the preferred grade.
e. The PC Workstations, File servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels. "Clones" are not acceptable.
f. Provide licenses for all software residing in the BMCS system and transfer these licenses to the Owner prior to completion.

3. Network:
   a. The BMCS shall incorporate a primary Tier 1 network. At the installer's option, the BMCS may also incorporate integrated secondary Tier 2 and tertiary Tier 3 networks.
   b. The BMCS Network shall utilize an open architecture capable of all of the following:
      1) Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec
      2) Connecting via BACnet at the Tier 1 level in accordance with as per ANSI/ASHRAE Standard 135.
      3) Connecting via the N2 Protocol at the Tier 2 level.
      4) Connecting via LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers at the Tier 2 level.
   c. The BMCS network shall support both copper and optical fiber communication media.
4. Third-Party Interfaces:
   a. BMCS installer shall integrate real-time data from systems supplied by other trades as required in Part 3.
   b. The BMCS system shall include necessary BMCS hardware equipment and software to allow data communications between the BMCS system and systems supplied by other trades.
   c. The trade installer supplying other systems will provide their necessary hardware and software and will cooperate fully with the BMCS installer in a timely manner at their cost to ensure complete data integration.
5. Uninterruptible Power Supply (UPS):
   a. Provide a UPS for all supporting operator PCs, servers, and other controls equipment.
   b. UPS shall be sized for 50 % spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.
6. Power Fail / Auto Restart:
   a. Provide for the automatic orderly and predefined shutdown of parts or all of the BMCS following total loss of power to parts or all of the BMCS.
   b. Provide for the automatic orderly and predefined startup of parts or all of the BMCS following total loss of power to those parts or all of the BMCS. Archive and annunciate time and details of restoration.
   c. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
   d. Maintain the BMCS real-time clock operation during periods of power outage for a minimum of 72 hours.

7. Downloading and Uploading:
   a. Provide the capability to generate BMCS software-based sequences, database items and associated operational definition information and user-required revisions to same at any Operator PC, and the means to download same to the associated Application Node.
   b. Application software tool used for the generation of custom logic sequences shall be resident in both the application node and the server(s) where indicated on the drawings.
   c. Provide the capability to upload BMCS operating software information, database items, sequences and alarms to the designated server(s).
   d. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual BMCS application.

B. Operator Workstations:
   1. The operator workstation PCs shall provide the primary means of communication with the BMCS and shall be used for operations, engineering, management, audit, reporting and other related functions.
   2. All PCs shall operate independently and concurrently without interference and under individual user password protection.
   3. PCs functionality shall be individually definable by software means such that PC may be designated for specific limited users and may also be readily re-designated to provide operator workstation back-up to other operator workstations in the BMCS.
   4. Portable operator terminals shall operate identically to the fixed operator workstation PC.
   5. Fixed or portable operator PCs shall not require any special software to be purchased from the BMCS manufacturer. All actions required for the complete operator interface as described herein shall be accomplished through a common browser.

C. Operator Interface:
   1. General:
      a. The BMCS Operator Interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BMCS by authorized users at the OWS.
      b. It shall be possible to designate any PC on the Tier 1 network as an Operator Interface point. No special software will need to be purchased from the BMCS manufacturer for any such PC.
      c. User access to the BMCS shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to on-line manage password access control under the control of a Master Password.
      d. The user interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.
      e. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
         1) User access for selective information retrieval and control command execution
         2) Monitoring and reporting
         3) Alarm, non-normal, and return to normal condition annunciation
         4) Selective operator override and other control actions
         5) Information archiving, manipulation, formatting, display and reporting
         6) BMCS internal performance supervision and diagnostics
         7) On-line access to user HELP menus
         8) On-line access to current BMCS as-built records and documentation

9) Means for the controlled re-programming, re-configuration of BMCS operation and for the manipulation of BMCS database information in compliance with the prevailing codes, approvals and regulations for individual BMCS applications.

f. Provide BMCS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the BMCS.

g. Each fixed and portable PC shall be on-line configurable for specific applications, functions and groups of BMCS points.

2. Navigation Trees:
   a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
   b. Provide the ability for the operator add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum five levels of nesting.
   c. The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
3. Dividable display panels:
   a. It shall be possible for the operator to divide the display area within a single browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided by the system.
   b. Provide each display panel with minimize, maximize, and close icons.
4. Alarms:
   a. Alarms shall be routed directly from primary application nodes to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the OWS software shall, at the minimum, provide the following functions
      1) Log date and time of alarm occurrence.
      2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
      3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
      4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
      5) Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop up window described above. Systems which use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
      6) Any attribute of any object in the system may be designated to report an alarm.
   b. The BMCS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
   c. The BMCS shall annunciate application alarms at minimum, as required by Part 3.
5. Reports:
   a. Reports shall be generated and directed to one or more of the following: User interface displays, printers, or archive at the user's option. As a minimum , the system shall provide the following reports:
      1) All points in the BMCS.
      2) All points in each BMCS application.
      3) All points in a specific AN.
      4) All points in a user-defined group of points.

5) All points currently in alarm in an BMCS application.
6) All points locked out in an BMCS application.
7) All BMCS schedules.
8) All user defined and adjustable variables, schedules, interlocks and the like.
9) BMCS diagnostic and system status reports.

b. Provide all applicable standard reports of the BMCS manufacturer.
c. Provide for the generation by the user of custom reports as specified in Part 3.

6. Dynamic Color Graphics:
   a. An unlimited number of graphic displays shall be able to be generated and executed.
   b. Graphics shall be based on Scalar Vector Graphic (SVG) technology.
   c. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
   d. The graphic displays shall be able to display and provide animation based on real-time BMCS data that is acquired, derived, or entered.
   e. The user shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
   f. Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.
   g. BMCS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical BMCS system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.
7. Schedules:
   a. The system shall provide multiple schedule input forms for automatic BMCS time-of-day scheduling and override scheduling of BMCS operations. At a minimum, the following spreadsheet types shall be accommodated:
      1) Weekly schedules.
      2) Temporary override schedules.
      3) Special “Only Active If Today Is A Holiday” schedules.
      4) Monthly schedules.
   b. Schedules shall be provided for each system or sub-system in the BMCS. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
   c. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.
8. Historical trending and data collection:
   a. Trend and store point history data for all BMCS points and values as selected by the user.
   b. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.
   c. At a minimum, provide the capability to perform statistical functions on the historical database:
      1) Average.
      2) Arithmetic mean.
      3) Maximum/minimum values.
      4) Range – difference between minimum and maximum values.
      5) Standard deviation.
      6) Sum of all values.
      7) Variance.

D. Application Nodes (AN):
   1. Primary Application Nodes
      a. The primary application node shall perform the function of monitoring all system variables, both from real hardware points, software variables, and controller parameters such as setpoints.
      b. Application nodes shall be entirely solid state devices. No rigid disk drives will be permitted in the equipment rooms.
      c. The primary application nodes shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier 2 networks, and to servers.
      d. Any node on the Tier 1 network shall be equipped with all software necessary to drive the complete user interface including graphics on a browser connected to the node via the network or directly via a local port on the node.
      e. The operating system of the application node shall support multi-user access. At minimum four users shall be able to access the same application node simultaneously.
      f. Communication between nodes shall be per-to-peer via 10/100 Ethernet using the BACnet protocol.
      g. The AN shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the controller not support multiple field busses, install two primary nodes side by side.
         1) An RS-485 serial field bus such as MSTP or the manufacturer's proprietary field bus.
         2) a LON field bus for supervision and control of LON based controllers that conform to the Lon Talk standard.
      h. The primary nodes will integrate data from both field busses into a common object structure. Data from both field busses will appear in common displays throughout the user interface in exactly the same format. It shall not be possible to determine which field buss the data originated on without reviewing the system configuration data.
      i. AN shall be programmable and governed by the requirements of their applicable codes, approvals and regulations.
      j. The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.
      k. A failure at an AN shall not cause failures or non-normal operation at any other system AN other than the possible loss of active real-time information from the failed AN.
      l. Ancillary AN equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.
      m. AN shall comply with FCC Part 15 subpart J class A emission requirements.
      n. Each primary node shall be equipped with the necessary un-interruptible power such that it will not cease operation during minor power outages, including those that occur upon transfer to emergency generator or other local power source not provided by the utility.
   2. HVAC Node:
      a. HVAC Node shall provide both standalone and networked direct digital control of HVAC systems.
      b. A dedicated HVAC Node shall be configured and provided for each primary HVAC system (air handler, chiller, boiler) and each terminal HVAC system (VAV Box, Unit Heater, Fan Coil Unit, Cabinet Heater, Heat Pump, Fan Powered Box, CV Box)
      c. Each HVAC Node shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.
      d. Each HVAC Node shall report its communication status to the BMCS. The BMCS shall provide a system advisory upon communication failure and restoration.
      e. For each primary HVAC system, provide means of indication of system performance and setpoints at, or adjacent to the HVAC Node.

f. For each primary HVAC system, provide a means to adjust setpoints and start/stop equipment at, or adjacent to the HVAC Node.
g. Provide a means to prevent unauthorized personnel form accessing setpoint adjustments and equipment control functions.
h. The HVAC Node shall provide the ability to download and upload configuration data, both locally at the Node and via the BMCS communications network.
i. The HVAC Node shall be provided with a permanently-mounted local graphic terminal where required in the sequences of this specification. The local graphic terminal shall provide dynamic graphical representation of the associated system status, with the ability for the operator to enter commands with proper password protection.

E. Application Software:
1. HVAC Application Software:
a. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined BMCS real-time event including equipment/point status change, approaching limit or alarm, time of day and the like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.
b. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.
c. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.
d. Energy monitoring: Provide software to monitor and totalize consumption as measured by pulse meters.
e. Event Initiated Programs and custom logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.
f. System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the BMCS. Provide appropriate time delays to prevent demand surges or overload trips.
g. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
h. Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.
i. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

2.6 ELECTRICAL SYSTEM AND DEVICES

A. All electric switch devices to be selected for applied and UL listed for application. All water thermostats provided with separable copper, monel, or stainless steel well.

B. Miscellaneous, electric, and mechanical devices to include:
1. Control dampers less actuators shall be provided under Section 23 31 13. Actuators shall be provided by controls installer.
2. Smoke dampers and actuators indicated on plans provided by Section 23 31 13. Actuator to be factory installed, coordinate type required.
3. Automatic control valves:
a. Chilled and heating water system control valves for new and existing air handling units shall be provided as follows:

1) Pressure independent valves with 100:1 turndown designed to maintain constant flow rate proportional to valve position regardless of inlet pressure.
2) 5% accuracy through selected operating pressure range calibrated per ANSI/NCSL Z540-1-1994.
3) Control valve bodies shall be cast iron, steel, or bronze rated at 150 PSIG. All internal parts shall be stainless steel, steel, Teflon, brass, or bronze. Plastic internal parts are not acceptable.
4) Use of valves shall eliminate need for manually balancing flow rate at each location. Valves shall have pressure ports to verify proper operation.
5) End type:
   a) 2-1/2 IN and smaller: Screwed.
   b) 3 IN and larger: Flanged.
6) Manufacturer: Belimo, Delta P, or equal.
7) Valves for fan coil units may be conventional type as specified for other systems.

b. Other systems:
1) Materials:
   a) Stems: Stainless steel.
   b) Packing: Spring loaded Teflon with replaceable discs.
   c) Body: Bronze.
2) End type:
   a) 2-1/2 IN and smaller: Screwed.
   b) 3 IN and larger: Flanged.
3) Water control valves, 4 IN size and larger: Butterfly type.
4) Valves ANSI rated to withstand pressures and temperatures encountered.
5) Modulating straight through water valves provided with equal percentage contoured throttling plugs. All 3-way valves provided with linear throttling plugs so total flow through valve remains constant regardless of valve's position. Valves sized for pressure drop equal to coil they serve, but not to exceed 5 PSI. Size 2-way valve operators to close valves against pump shut off head.
6) Modulating steam valves to have linear characteristics for 90 % of closing stroke, and equal percentage for final 10 %. Valves sized for entering steam pressure indicated with pressure drop through valves not to exceed 20 % of main steam pressure.

c. Terminal equipment valves to be straight through or 3-way type as indicated. Stems polished stainless steel and packing ethylene-propylene suitable for both chilled water and 250 degree F hot water service. Pressure ratings as required for intended service.

4. Firestats: 130 degree F manual reset type.
5. Safety low limits: Snap acting, single pole, single or double throw, manual reset switch which trips if temperature sensed across any 12 IN of bulb length is equal to or below setpoint, requiring minimum 20 FT length of bulb. Provide one thermostat for every 20 square feet of coil surface. Mount freeze protection thermostats using flanges and element holders. Low limit thermostats shall have multiple contacts or shall be installed with relay loop to allow low limit thermostats to be directly connected to the motor starter/VFD and to the BMCS.
6. Electric thermostats: Line voltage or low voltage type suitable for application. Low voltage type heating thermostats to have adjustable heat anticipation.
7. Instrument pressure gauges: Black letters on white background, 1-1/2 IN diameter, stem mounted with suitable dial range. Install pressure gages on main and branch lines at each receiver controller, at input to each actuator, at inputs and outputs from each relay and switch, and signal lines at each transmitter.
8. Electric Damper Actuators.
   a. Rating: NEMA 1 Enclosure
   b. Mounting: Direct mount
   c. Stroke: 90 seconds end to end full stroke, 15 seconds return to normal for spring return
   d. Protection: Electronic stall protection

e. Control Input: 0-10 VDC or 0-20 mADC
f. Power: Nominal 24 VAC
g. Torque: Size for minimum 150 % of required duty
h. Duty cycle: Rated for 65,000 cycles
i. Special:
   1) Modulating actuators: Output position feedback
   2) Two position actuators: Two auxiliary contacts for actuator position
   3) Manual override
   4) Field selectable rotational / spring return direction
   5) Field adjustable zero and span

9. Electric Valve Actuators:
   a. Rating: NEMA 1 Enclosure
   b. Mounting: Direct mount
   c. Control Input: Continuous 0-10 VDC or 0-20 mADC
   d. Power: Nominal 24 VAC
   e. Protection: Stall protection
   f. Torque: Size for minimum 150 % of required duty
   g. Special:
      1) Modulating actuators: Output position feedback
      2) Two position actuators: Two auxiliary contacts for actuator position
      3) Manual override.
      4) Field selectable direction.
      5) Field adjustable zero and span
      6) For spring return, provide field selectable spring return direction

2.7 ELECTRONIC DATA INPUTS AND OUTPUTS

A. Input/output sensors and devices matched to requirements of remote panel for accurate, responsive, noise free signal output/input. Control input to be highly sensitive and matched to loop gain requirements for precise and responsive control.
   1. In no case shall computer inputs be derived from pneumatic sensors.

B. Temperature sensors:
   1. Except as indicated below, all space temperature sensors shall be provided with single setpoint adjustment with temperature display and unoccupied mode override button. The following are exceptions to this:
      a. The following locations shall have sensor without setpoint adjustment:
         1) All electrical and communication rooms.
         2) All mechanical rooms.
         3) All unit heaters.
         4) All public elevator lobbies and entrance vestibules.
         5) Elevator equipment rooms.
   2. Duct temperature sensors to be averaging type. Averaging sensors shall be of sufficient length (a maximum of 1.8 sqft of cross sectional area per 1 lineal foot of sensing element) to insure that the resistance represents an average over the cross section in which it is installed. The sensor shall have a bendable copper sheath. Water sensors provided with separable copper, monel or stainless steel well. Outside air wall mounted sensors provided with sun shield.
   3. Outside air, return air, discharge air, return air, space, and well sensors to be linear with ± 0.7 °F between 32 °F and 212 °F.

C. Relative humidity sensors to be capacitance type with 10 % to 90 % range with an accuracy of ± 2 % of full scale. Duct mounted humidity sensors provided with sampling chamber.

D. Differential and static pressure sensors and switches:
   1. The pressure transducer shall withstand up to 150 % of rated pressure with and accuracy of plus or minus 1 % of full scale. The sensing element shall be either capsule, diaphragm,

bellows, bourbon tube, or solid state. Pressure sensors (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure sensors shall have valves for isolation, venting and taps for calibration. Pressure sensors shall be verified by calibration. Differential pressure sensors shall have nulling valves.

2. Pressure switches shall have a repetitive accuracy of ± 2 % of their operating range and shall withstand up to 150 % of rated pressure. Switch shall have a snap acting form C contact rated for the application. Provide Dwyer 3000 series photohelic gauges with isolation valves and calibration taps, required power supply, and manual reset push button. Pressure switches (all types installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure switches shall have valves for isolation, venting and taps for calibration. Pressure switches shall be adjusted to the proper set point and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection. Differential pressure switches shall have nulling valves. Switch contact ratings and duty shall be selected in accordance with NEMA ICS 1.
3. Fan proof-of-flow sensor to be current switch.
4. Pump proof-of-flow sensor to be current switch.
5. Provide differential pressure gauges for air handling unit filters in pressure ranges to match full loaded filter pressure drop plus 50 % with manual reset and set point indication. Provide with isolation valves and calibration taps.

E. Flow measurement devices:
   1. Electronic Airflow Stations:
      a. Air Flow and Temperature Measurement:
         1) Thermal dispersion technology anemometer using instrument grade self-heated thermistor sensors with thermistor temperature sensors.
         2) Factory tested prior to shipment and shall not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
         3) Manufacturer shall provide test data for accuracy performance prior to bid date. Vortex shedding arrays are not acceptable. Pitot tube and differential pressure sensing arrays are not acceptable. Auto zeroing sensors are not acceptable.
      b. Flow Station Construction:
         1) Duct or fan inlet mounted as indicated.
         2) Sensors: Two glass-encapsulated thermistors at each measuring point - self heated thermistor and temperature sensor.
            a) Glass-filled polypropylene housing.
            b) Factory-calibrated at 16 airflow rates and 3 temperatures to NIST-traceable standards for both airflow and temperature.
         3) Duct mounted probe construction:
            a) Gold anodized aluminum alloy tube.
            b) 304 stainless steel mounting brackets.
            c) Constructed as insertion, internal, or standoff mounting, depending on installation requirements.
            d) Probe sensor density:

Area (sq.ft.)	Sensors
<= 1	2
>1 to< 4	4
4 to < 8	6
8 to < 12	8
12 to < 16	12
>= 16	16

            e) Probe operating ranges:
               (1) Airflow: 0 to 5000 FPM, ± 2 %

(2) Temperature: -20 to 160 °F, ± 0.15 ºF
(3) Relative Humidity: 0 to 99 % non-condensing
f) Installed accuracy of ± 3 % of reading or better.
4) Fan inlet mounted probe construction:
a) Gold anodized aluminum alloy tube
b) 304 stainless steel mounting brackets.
c) Probe operating ranges:
(1) Airflow: 0 to 10,000 FPM
(2) Temperature: -20 to 160 °F, ± 0.15 ºF
(3) Relative Humidity: 0 to 99 % non-condensing
d) Installed accuracy of ± 10 % of reading or better.

c. Transmitter:
1) Type: Microprocessor Based, totally solid state.
2) Power Requirement: 24 VAC, isolated from other devices and not grounded. AFMS manufacturer shall furnish a 1:1 isolation transformer for each duct location.
3) Capable of processing up to 16 independent sensing points per location.
4) Output signal offset/gain adjustment.
5) Adjustable digital filter to stabilize airflow output.
6) Field configurable for either I.P. or S.I. units.
7) Local digital display on face of cabinet for indicating individual sensor airflow and temperature readings.
8) Wall-mounted NEMA 1 enclosure.

d. The temperature control installer shall be required to calibrate the airflow sensors with input from the air balancing provider. Air flow readings shall be taken for at least five air flows through the range of operation and fit to a linear equation and programmed into the software.

e. Performance:
1) Electronics temperature range: 30 to 120 °F.
2) Flow station pressure drop: less than 0.005 IN WC at 2000 FPM.

f. Analog output signals:
1) Two field selectable (0-10 VDC or 4-20 mA), scalable and isolated analog output signals (AO1=airflow, AO2=temperature or alarm)
2) Type: Linear

g. Manufacturer: Ebtron Gold Series

2. Water and steam flow meters:
a. Turbine flow meters:
1) Steam flow meter:
a) Type: Insertion turbine type with retractable probe assembly and 2 IN full port gate valve.
b) Pipe size: 3 to 24 IN.
c) Retractor: ASME threaded, non-rising stem type with hand wheel.
d) Mounting connection: 2 IN 150 PSI flange.
e) Pressure transmitter: Mount in the retractor assembly to provide pressure signal.
f) Rotor assembly: Design for expected steam flow and pipe size.
g) Seal: Teflon (PTFE).
h) Controller:
(1) Integral to unit.
(2) Locally display flow rate and total.
(3) Output flow signal to BMCS: Digital pulse type.
(4) Output pressure signal to BMCS: 4-20mA with digitally adjusted span.
i) Performance:
(1) Accuracy: 1.0 % of reading
(2) Repeatability: 0.25 % of reading

(3) Turndown: 30:1
j) Power: 24 volt DC
k) Manufacturer: Emco TMP-910

2) Water flow meters:
a) Type: Insertion dual turbine type with retractable probe assembly and 2 IN full port gate valve.
b) Pipe size: 3 to 24 IN.
c) Retractor: ASME threaded, non-rising stem type with hand wheel.
d) Mounting connection: 2 IN 150 PSI flange.
e) Rotor assembly: Design for expected water flow and pipe size.
f) Seal: Teflon (PTFE).
g) Performance:
(1) Accuracy: 2.0% of reading
(2) Repeatability: 0.25% of reading
(3) Turndown: 50:1
h) Controller:
(1) Configured for energy meter (ton-hours consumption)
(2) BMCS output option cards to permit energy pulse and 4-20 mA demand signals in addition to on-board Ethernet capability
(3) Locally display flow rate and total
i) Power: 24 volt DC
j) Manufacturer: Onicon F-1200, with System 10 BTU Meter

b. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.
c. The temperature control installer shall be required to calibrate the flow meter with input from the balancing provider (Section 20 08 00). Flow readings shall be taken for at least five flows through the range of operation and fit to a linear equation and programmed into the software.
d. The energy meters shall require that the totalized energy log be trended in EMS at project startup, and the trends configured for permanent archive storage to removable media (a USB storage device of no less than 500GB) provided as part of the system workstation (not on the system's hard drive).

F. Plumbing Systems Devices:
1. Temperature transmitter:
a. Transmitter shall be two-wire, 24-Vdc power supply, 4-20 mA output.
b. RTDs shall be three or four wire, 100-ohm platinum, 0.00385 TCR per IEC Publication 751.
c. RTD and transmitter shall be matched pair.
d. Accuracy shall be:
1) Type 1: plus or minus 0.1 degree F.
2) Type 2: plus or minus 0.5 degree F.
3) Type 3: plus or minus 1 degree F.
e. Each matched pair shall have calibration documentation.
f. For liquid service:
1) Mounting shall be direct mount with a 1 inch NPT tapered thermowell with a 3-inch leg.
2) Thermowell shall be sized for tip to be midstream of process.
g. Approved manufacturers:
1) Burns Engineering
2) Minco
3) Vaisala
4) Rosemount

2. Pressure transmitter:
   a. Pressure transmitter shall be electronic-variable capacitance type with integral direct-reading meter. All transmitters shall be two-wire, 24-Vdc, 4-20 mA dc output with lead impedance of zero to 600 ohms, minimum.
   b. Instrument range shall be 40 percent to 80 percent of the maximum adjustable range.
   c. Accuracy of pressure transmitters shall be:
      1) Type 1: plus or minus 0.1 percent of calibrated span.
      2) Type 2: plus or minus 0.25 percent of calibrated span.
   d. The instrument shall operate in a temperature environment of minus 20 degrees F to plus 200 degrees F.
   e. Fluid or electronic-type damping with adjustment shall be provided.
   f. Wetted parts, including process flanges and drain/ vent valves, shall be 316 stainless steel. Wetted O-rings shall be Viton.
   g. Housing shall be modular with separate compartments for electronics and field connections.
   h. Fill fluid shall be silicone.
   i. Process connections shall be 1/2 inch NPT.
   j. Enclosure shall be NEMA 4X.
   k. Mounting shall be either pipe or wall with brackets with Series 300 stainless steel bolts.
   l. The transmitter shall withstand, without damage, a minimum over-pressure of 2 times the maximum pressure of the service or 2 times the maximum pressure of the system in which the instrument is being installed.
   m. Approved manufacturers:
      1) Foxboro
      2) Rosemount
      3) Yokogawa
3. Dew point transmitter:
   a. Transmitter shall be two-wire, 24-Vdc, 4-20 mA output.
   b. Accuracy shall be plus or minus 1 percent of dew point range.
   c. Range shall be minus 100 to plus 50 degrees F.
   d. Approved manufactures:
      1) Edgetech
      2) GE
4. Flow meter, vortex shedding:
   a. The flow meter shall be capable of measuring liquid or gas flow with an accuracy of at least plus or minus 0.7 percent of rate.
   b. The flow meter repeatability shall be at least 0.2 percent of rate.
   c. Flow element:
      1) Flow element shall be of the vortex-shielding type with a 316L cast stainless steel meter body and shedder bar.
      2) Flanged or wafer-style process connections are to be available.
      3) The meter body shall be rated for the vacuum to pressure rating of the mating end connections.
      4) Standard process temperature limits shall be from minus 40 degrees F to plus 450 degrees F.
   d. Flow transmitter:
      1) The flow transmitter shall be able to be mounted either integral to, or remote from, the meter body.
      2) The flow transmitter shall be loop powered and require a power source of 12 to 42 Vdc.
      3) The flow transmitter shall provide a 4-20 mA output.
      4) A local LCD indicator shall be available as an option.
   e. Approved manufacturers:
      1) Foxboro.
      2) Rosemount.

3) Bailey Fisher & Porter.
4) Yokogawa.

5. Flow meter, electromagnetic (mag):
   a. The flow meter shall be capable of measuring the flow of conductive liquids, with an accuracy of at least plus or minus 0.5 percent of rate.
   b. Flow Element:
      1) Flow element shall be of the magnetic type and of 304 stainless steel construction.
      2) Flanged or wafer-style process connections are to be available.
      3) Flow tube liner shall be of appropriate construction for application.
      4) Electrodes are to be of appropriate construction for application.
      5) The temperature rating of the flow element and its materials of construction shall be suitable for use in the specified service.
      6) The pressure rating of the flow element shall meet or exceed the pressure rating of the piping system in which it is to be installed.
   c. Flow Transmitter:
      1) The flow transmitter shall be capable of either integral or remote mounting up to 50 feet from the flow element.
      2) Remotely mounted flow transmitters shall be connected to the flow element via a vendor-supplied cable.
      3) The flow transmitter shall be able to be specified with either a 120-VAC or 12 to 30 Vdc power source.
      4) The flow transmitter shall provide a 4-20 mA output.
      5) A local LCD indicator shall be available as an option.
   d. Approved manufacturers:
      1) Foxboro
      2) Rosemount
      3) Bailey-Fisher & Porter
      4) Yokogawa
6. Level transmitter, ultrasonic:
   a. The ultrasonic level system shall be capable of measuring the level of the process fluid, and if required, calculating the corresponding volume or flow with an accuracy of at least plus or minus 0.5 percent of full scale.
   b. The ultrasonic level system shall incorporate automatic temperature compensation.
   c. Ultrasonic level sensors:
      1) The ultrasonic level sensor shall be fully submersible to IP68.
      2) The ultrasonic sensor shall measure over the specified range and be mounted in such a position as to prevent interference form side walls, process piping, etc.
      3) All sensors shall be field replaceable.
   d. Ultrasonic level transmitter:
      1) The ultrasonic transmitter shall be housed in a NEMA 4X enclosure.
      2) The ultrasonic transmitter shall be capable of remote mounting up to 1,000 feet away from the sensor.
      3) The ultrasonic transmitter shall operate from a 120-VAC, 60-Hz or 24-Hdc power source.
      4) The ultrasonic transmitter shall provide an isolated 4-20 mA output into a maximum load of 600 ohms, and shall be range settable.
      5) The ultrasonic transmitter shall be fully field programmable.
      6) The ultrasonic transmitter shall incorporate a digital display capable of displaying level/volume and process temperature.
      7) The ultrasonic transmitter shall perform on-line sensor diagnostics for continuous monitoring of the ultrasonic sensor.
   e. Approved manufacturers:
      1) Magnesonic.
      2) Magnetrol.

7. Conductivity/resistively sensor:
   a. The conductivity/resistivity monitoring system shall be capable of measuring the conductivity or resistivity of the specified fluid in megohms-cm with an accuracy of at least plus or minus 0.5 percent reading.
   b. The system shall provide for electrical calibration or manual calibration with grab samples, etc.
   c. The system shall have an optional provision for multichannel and/or multiparameter operation.
   d. Sensors:
      1) Appropriate sensor cell constant shall be determined for each application.
      2) An integral temperature sensor shall be incorporated in the probe assembly and will provide for temperature compensation of the conductivity reading and temperature measurement of the process fluid.
      3) All electrodes shall be field replaceable.
      4) Sensors shall be insertion or retractable type as indicated on the Drawings.
   e. Transmitter:
      1) The transmitter shall be housed in a NEMA 4X enclosure.
      2) The transmitter will incorporate automatic temperature compensation referenced to 25 degC.
      3) The transmitter shall be capable of remote mounting up to 200 feet away from the sensor.
      4) The transmitter shall operate from a 24 VDC power source.
      5) The transmitter shall provide an isolated 4-20 mA output into a maximum load of 500 ohms and shall be range settable.
      6) The transmitter shall be fully field programmable.
      7) The transmitter shall incorporate a digital display capable of displaying conductivity or resistivity and process temperature.
      8) The transmitter shall perform on-line sensor diagnostics for continuous monitoring of the conductivity sensor.
      9) The transmitter shall incorporate a hold function to maintain a fixed output while maintenance/calibration is being carried out.
   f. Approved manufactures:
      1) Thornton M300 Series.

G. Outputs: Control relays and analog output transducers to be compatible with remote panel. Relays suitable for loads encountered. Analog output transducers designed for precision closed loop control with pneumatic repeatability error no greater than 1.5 %.

PART 3 - EXECUTION

3.1 GENERAL

A. The Building Management and Control System (BMCS) shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner; including all labor not noted in the Work by Others paragraph of Part 1 of this Section of these specifications, and not noted in other Sections of these specifications.

3.2 SEQUENCE OF OPERATION

A. General:
   1. HVAC systems shall be controlled with Direct Digital Control (DDC) according to sequence contained within the drawings and shall be stand-alone.
      a. Additional points or software programming not listed but which are required to meet following sequences of operation shall be provided.

2. House controllers, relays, transducers, and other components required for stand-alone control in NEMA 1 enclosure with lockable door.
3. All VFD's shall be monitored by BMCS for trouble conditions. Signal shall be a set of dry contacts. Operator will use VFD control panel for diagnostics.
   a. VFD start/stop, e-stop and speed reference control must be hardwired pilot relay contacts and 0-10VDC analog signals. LAN commands for VFD control are not acceptable.
4. Setpoints:
   a. All setpoints given in the sequence of operations or in the drawings are for system startup and are preliminary. Optimum operating setpoints must be determined during actual occupancy and will be affected by many factors. These may include:
      1) Weather conditions.
      2) Building occupancy.
      3) Building utilization patterns.
      4) Variations in building construction.
      5) Variations in operating characteristics of actual installed building equipment.
   b. It is the responsibility of the building operators to determine those settings and operating methods which provide the best balance of operating efficiency and occupant comfort. This is an ongoing process. Optimum settings change as operating conditions change.
   c. Current switches for motor starters shall be set to indicate failure of motor. For motors with VFDs, the setting shall be below normal minimum operating point. For belt driven motors, the setting shall be capable of detecting belt breakage.
5. The position of all valve and damper actuators shall be communicated to the BMCS.
   a. Modulating actuators: Utilize feedback signal integral to actuator (or equivalent external device).
   b. Two position actuators: Utilize auxiliary contacts integral to actuator (or equivalent external device) to indicate full open position. Full closed position shall also be indicated where specifically required by sequence of operation.
   c. Position feedback shall not be required for air terminal unit, unit heater, or fan coil unit actuators.
6. Where space temperature sensors have setpoint adjustment and unoccupied mode override button, the unoccupied mode shall be overridden to occupied mode of operation for one hour (adj.), unless specified otherwise.

3.3 DATA CONTROL (D/C) AND GRAPHICS

A. Provide all programming required to accomplish sequence of operations, including all data and control points not listed on input/output points summary shown on plans.

B. In addition to graphics of building systems with dynamic data points as noted in following data and control and graphic summary, and graphics required under digital system management sections, following additional graphics shall be provided:
   1. Building layouts (floor plans).
   2. Any other graphics necessary for logical penetration.
   3. Sequence of operation (window split screen view).
   4. Flow charts for critical DDC loops and existing building.
   5. Supervisor graphics.
   6. System configuration.
   7. Display VVR and CVR boxes, and reheat coil locations on building floor plans. This applies only to boxes specified with DDC control.
   8. Display fire and smoke damper locations on building floor plans.
   9. Display air handling unit locations and configuration (flow diagram, DDC Logic Diagram and control sequence).
   10. Display domestic water mains and valve locations with valve I.D. corresponding to valve index indicating service, size, valve type, and location.

11. Display heating, and chilled water mains and valve locations with valve I.D, corresponding to valve index indicating service, size, valve type, and location.
12. Display steam supply and return mains, valve location, and trap locations with valve I.D. corresponding to valve index indicating service, size, valve type, and location.
13. Flow diagram of steam system for new building showing PRVs, and display all points indicated on I/O summary.
14. Flow diagram of chilled water and heating water systems for new building showing variable speed pumps and locations of differential pressure switches, and display all points indicated on I/O summary.
15. Display all DDC sensors, thermostats, and humidistats on floor plan corresponding to air terminal or other controlled device locations.
16. Display all DDC panels, indexed to correspond with system configuration.

C. Include Pseudo points for display in logical groups and graphics. Command pseudo points to be command directly from displays.

D. Each analog point to have unique remote panel resident dual high, and dual low limit alarm threshold engineering units. Where specified, provide floating (band above and below setpoint) alarm limits.

E. Each digital output to have software-associated monitored input. Anytime monitored input does not track its associated command output within programmable time interval, "command failed" alarm shall be reported.

F. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups. Respective unconditioned raw data (such as logarithmic differential pressure) points to also be grouped in special group for display and observation independent of logical groups.

G. Where data or control points are required to accomplish digital control or energy management sequences specified, but not listed in I/O summary, installer shall provide the points necessary to accomplish the specified sequence.

H. Primary analog input and analog output of each DDC loop to be resident in single remote panel containing DDC algorithm, and shall function independent of any peer or mux communication links. Secondary (reset type) analog inputs may be received from the peer network, but approved default values and/or procedures shall be substituted in DDC algorithm for this secondary input in network communications fail or if secondary input becomes erroneous or invalid.

3.4 INSTALLATION

A. All wiring and tubing to be properly supported, and run in neat and workmanlike manner. All wiring and tubing shall run parallel to or at right angles to building structure. All piping and wiring within enclosures to be neatly bundled, and anchored to prevent obstruction to devices and terminals.

B. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and pilot lights, push buttons and switches flush on cabinet panel face. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved nameplate on cabinet face.

C. Electrical wiring:
1. BMCS installer: responsible for all electrical installation required for fully functional system, and not shown on electrical plans or required by electrical specifications.
2. Code compliance: All local and national codes.

3. Wiring size: #18 AWG minimum THHN, shielded where required by manufacturer or installation.
4. Line voltage and low voltage control wiring installation: in conduit.
5. Power supply:
   a. Coordinate with electrical engineer and electrical installer.
   b. BMCS installer: responsible for costs associated with installation of power supply from electrical panel to control device(s).

D. Identification:
1. Provide laminated plastic nameplates for control panels. Other equipment devices furnished, including sensors, switches, valves, gauges, actuators and all other item furnished under this Section shall be identified with plastic embossed labels adhered to the device. Each nameplate shall identify the function, such as "mixed air low limit" or "cold deck temperature sensor" Laminated plastic shall be one-eighth inch thick whiter with black center core. Nameplates shall be a minimum of 1 IN xy 3 IN with minimum one quarter inch high engraved block lettering. Nameplates for devices smaller than 1 IN x 3 IN shall be attached by a nonferrous metal chain. Submit proposed wording of each nameplate with hardware submittal.
2. Instrumentation and Control Diagrams: Provide framed drawings including the sequence of controls and verbal description in laminated plastic showing complete diagrams for all equipment furnished and interfaces to all existing equipment, at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed form, framed as specified for the diagrams and posted beside the diagrams. Proposed diagrams, instructions and other sheets shall be submitted prior to posting.

E. BMCS installer to enter all computer programs and data files into related computers, including all control programs, initial approved parameters and settings, English descriptors, and colorgraphics complete with dynamic dispersed data. In addition, following to be user implemented, shall have samples installed for training and validation:
1. Trend log.
2. Alarm message (action taking message).
3. Run time maintenance message.
4. Trouble action message.
5. Dynamic trend plot (6 points).

F. BMCS installer to maintain copies of all data file, and application software for reload use in event of system crash or memory failure. One copy to be delivered to Owner during training session, and one copy archived at local software vault provided by BMCS manufacturer within 10 miles of OS.

G. Pressure transmitters:
1. Static pressure transmitters must not be field-mounted in concealed locations.
2. Route pressure sensing lines from remote sensors to transmitters with display mounted in the associated equipment control panels.
3. Remote sensor locations must be clearly specified in documentation and graphic interface displays, and marked on ceiling access hatches or tiles where visible from occupied common areas.

H. Mount local control panels at convenient location adjacent to equipment served.
1. Mount relays, PE switches, pressure switches, etc., on rear of temperature control panels. Tag each instrument by using "Dymo" tape corresponding to symbols used on control diagrams.

I. Locate panels so visual observation and adjustment can be accomplished from floor level.

J. Room sensors:
   1. Unless indicated otherwise, locate thermostats, humidistats and sensor for room control, and monitoring immediately inside of door adjacent to light switch.
      a. Where light switch is in an entry way to room, locate on wall within room so it is capable of sensing true space conditions.
      b. Prior to installation, coordinate locations with Architect/Engineer.
      c. Mount at 48 IN above finished floor to top of control box.
   2. All room temperature and humidity sensors indicated in the control sequences shall be provided whether or not a location is indicated on the plans. If a location is not shown, allow for a maximum of 100 FT of wiring between the sensor and terminal unit or equipment. Submit Request for Information (RFI) to confirm sensor location with Architect.

3.5 VALIDATION

A. Submit test plan and test procedures for the performance verification tests for approval. Explain in detail actions and expected results to demonstrate compliance with the requirements of this specification and the method for simulating the necessary conditions of operation to demonstrate performance of the system. Deliver Test Plans documentation for the performance verification tests to the owner's representative 30 days prior to the performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.

B. BMCS installer shall completely checkout, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Calibration to be demonstrated by the BMCS installer in the presence of the Architect or Owner's representative, as dictated by the Owner. representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the owner.

C. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.

D. Make accessible, personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.

E. After completion of validation procedures, installer shall perform validation demonstration in the presence of the Architect or Owner's representative, as dictated by the Owner. Record the outcome of each test noting actual outcomes and discrepancies. Submit detailed report of outcomes. Witnessed validation demonstration and associated report shall consist of:
   1. Running each specified report and recording outcomes.
   2. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
   3. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
   4. Execute digital and analog commands in graphic mode.
   5. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
   6. Demonstrate EMS performance via trend logs and command trace.
   7. Demonstrate scan, update, and alarm responsiveness.
   8. Demonstrate spreadsheet/curve plot software, and its integration with database.
   9. Demonstrate on-line user guide, and help function and mail facility.
   10. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.
   11. Demonstrate multi-tasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
   12. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

3.6 MANUALS (FOLLOWING MANUALS TO BE PROVIDED)

A. Functional design manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be provided for all system operating modes.

B. Hardware manual: Furnish a hardware manual describing all equipment provided including a general description and specification, installation and checkout procedures, equipment electrical schematics and layout drawings, system schematics and I/O wiring lists, and alignment and calibration procedures.

C. Software manual: The software manual shall describe all furnished software, starting with a system overview and proceeding to a detailed description of each software module. The manual shall be oriented to enable proper integration, loading, testing and program execution. Provide flow charts or diagrams or equivalent documentation, as approved in advance by owners representative, in hard copy enabling the logical step by step analysis of the program listings. Substitutions of different format are not acceptable.

D. Maintenance Manual: The maintenance manual shall provide descriptions of maintenance for all equipment including inspection, periodic preventative maintenance, fault diagnosis and repair or replacement of defective components.

3.7 TRAINING

A. All training to be by BMCS manufacturer and utilize specified manuals, as-built documentation, and on-line help utility.
   1. No training should occur until complete As-Built documentation has been delivered and TAB completed, even if not with final EOR approval.

B. Provide complete demonstration of equipment or systems requiring seasonal operation, during operating season. Perform multiple demonstrations when required within six months.

C. Provide experienced instructor(s) to teach Owner's personnel operation, adjustment, testing, trouble shooting and maintenance of the system. Include detailed training instruction manuals delivered for each trainee which contain any operations specific to this project.

D. Provide for a training period of five days on-site as described below. Scheduling will be at discretion of Owner; training days may not be consecutive.

E. Operator training shall be for five (5) personnel, and shall include one initial 8 hour session encompassing:
   1. Sequence of operation review.
   2. Sign on-sign off.
   3. Selection of all displays and reports.
   4. Commanding of points, keyboard, and mouse mode.
   5. Modifying English text.
   6. Use of all dialog boxes and menus.
   7. Modifying warning limits, alarm limits, and start-stop times.
   8. System initialization.
   9. Download and initialization of remote panels.
   10. Purge and/or dump of historical data.
   11. Use of portable operator's terminal.
   12. Troubleshooting of sensors (determining bad sensors).
   13. Password modification.

F. After initial Operator training, BMCS manufacturer shall include one additional 8 hour session of Operator training for miscellaneous instruction requested by the Owner.

G. Supervisor training shall be for six (6) personnel, and shall include one additional 8 hour session encompassing:
   1. Password assignment/modification.
   2. Operator assignment/modification.
   3. Operator authority assignment/modification.
   4. Point disable/enable.
   5. Terminal and data segregation/modification.
   6. Use of portable operator terminal.
   7. Use of spreadsheet package with system data.

H. Programmer training shall be scheduled by Owner with two week notice anytime during warranty period. Programmer training shall be for two (2) personnel, and shall include two additional 8 hour sessions encompassing:
   1. Software review of sequence of operation and flow charts.
   2. Modification of control programs.
   3. Add/delete/modify data points.
   4. Use of diagnostics.
   5. System maintenance procedures.
   6. Review of initialization.
   7. Upload/download and off-line archiving of all system software.
   8. Graphic creation.

END OF SECTION

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SECTION 25 51 00
UCR CONTROLS SYSTEMS STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Energy Management Systems (EMS) requirements for the UCR campus is outlined in this Section.

B. Where controls work provided under other specification Sections conflict with this Section, this Section shall govern with guidance from UCR Physical Plant.
   1. Building Management and Control System: See Section 25 50 00.

1.2 DESCRIPTION

A. UCR owns an extended legacy Johnson Controls Metasys network of Network Control Modules/Units (NCMs/NCUs) with Person-Machine Interface (PMI) front end, and one new facility off campus on the supported MSEA architecture, with an Application and Data Server (ADS) front end.

B. Batchelor Hall utilizes existing NCM350 panels and shall be upgraded with the new generation Network Automation Engine (NAE) panels, and upgrade Terminal Equipment Controllers (TEC) with DX9100 or most current replacement. Any new controllers and addresses shall be compatible with the MSEA N2.

C. The building network architecture shall be a standalone private network within the building envelope, with ALL communications hardware installed and "owned" by the controls contractor. This must include all routers, switches, cabling, gateways, converters etc. as needed for a fully functioning full-building control system which is physically discrete from the campus Ethernet. Integration between new and existing building devices must not rely on switches or servers managed by UCR Network Services.

D. The building operation must not rely on network ports or points of connection which are part of the existing Ethernet owned and managed by UCR Networks Services. Any integration with the existing EMS must be identified during discovery, and planned and coordinated by the controls contractor, supported if necessary by UCR Physical Plant. Assuming that UCR Network Services will provide network ports or IP addresses for integration within building will not be acceptable.

E. Once existing campus Ethernet connectivity is established via a UCR managed hub, the controls planners shall produce front end graphics and database for the MSEA ADS, rather than for the existing unsupported legacy PMI front end. Any subsequent migration of data back to the legacy network would then be Physical Plant's responsibility.

F. Current NCM architecture:
   1. NCM panels communicating on N2 Local Area Network (LAN) with TECs.
   2. Fiber optic converter and Ethernet switches located at Steam Plant.
   3. Front end Personal Computer (PC) located at Steam Plant.

G. MSEA architecture:
   1. Culver Arts Museum downtown has NAE and various VMA/UNT/DX9100 controllers.
   2. N1 via internet to main campus ADS front end in Steam Plant.
   3. Network Integration Engine (NIE) integrating NCM network at the Steam Plant.

1.3 SPECIFICATIONS FOR UCR METASYS DATA

A. Mapped Metasys Objects:
1. Point naming convention subject to approval by Physical Plant. Review before programming.
2. Commandable output object names shall be ALL UPPERCASE (e.g. SF-ENABLE, BYPASS-C, CHW-VLV) where the application permits.
3. Input/status objects (non-commandable) shall be Upper And Lower Case (e.g. DA-Temp, StaticP, HWS-Temp) where the application permits. 8-character object names are preferred.
4. N2 Hardware Descriptions of Zone Controllers shall include room numbers for all served spaces (e.g. Zone Ctrl 2110,2115,2117,2320) wherever possible.
5. Hi-Lo X-Y parameters for temperature reset schedules shall be individually mapped, and clearly depicted in graphic displays.
6. Every system (AHUs, Secondary Pump systems etc.) shall include an Enable point for scheduling/override. The Enable point will initiate orderly system startup/shutdown.

B. Programmable Controller Configuration Files:
1. ALL used inputs/outputs shall be named according to UCR form (i.e. outputs in uppercase etc.).
2. I/O names and descriptions in config files shall match Metasys mapped object names.
3. Generic controller files shall not be used. Each controller file must be unique to the controller, and the file name shall incorporate the controller hardware ID.
4. ALL GX9100 files shall be accompanied by a separate Tag File with matching file name.
5. Configuration file names (ASC, DX9100) shall match N2 Hardware Object names (i.e. DX001N01.cfg).
6. Unused or old config files shall be removed from the Project directory when replaced.

C. Device Names:
1. N2 Hardware Object names shall follow this 8-character form:
DX001N01 1st two characters = device type
2nd three characters = N2 address
Last two characters = Host NC node
2. N2 Hardware Object descriptions shall reference equip. ID and location when possible (i.e. "Flr2 AHU2 Rm219", "HHW System RmB059"). See above note for Zone Controllers description.

D. Archive Data:
1. ALL config files for field devices shall be saved in the Project Directory. ASC files shall be saved in a folder named "HVACPRO". GX9100 files shall be saved in the SYSTEM91 folder, etc.
2. Tag files as described above shall accompany all GX9100 files.

E. As-Built Documentation:
1. Sequence Of Operation text shall specify the process location and controller file name where applicable (i.e. AHU1 Economizer Control resides in device DX001N01. Supply Air Temperature Reset is controlled by GPL process "AHU1" in system "PS1-AHU1").

1.4 GENERAL REQUIREMENTS

A. Basis of Design:
1. All environmental, utility, and process controls to be either directly controlled by EMS devices, or networked to existing EMS via standard protocol (BACnet preferred) or gateway when available unit controls are integral to equipment only.
2. Submittals for equipment controlled by means of gateway or other communication protocol shall include a list of available points and attributes compatible with the building EMS. Approval of equipment selection shall be subject to Physical Plant review of the control interoperability.

3. Field I/O devices shall be selected to provide 25% spare capacity of each point type for future expansion. Zone terminal controllers are exempted.
4. Recirculating air handling systems shall include a demand-based ventilation cycle for control of IAQ, with sensors provided for outside and inside air carbon dioxide levels.
5. Enthalpy-based control of air handler economizer switchover is preferred over dry-bulb temperature control. Economy cycle cooling capacity shall be modulated to prevent increasing zone reheat demand.

B. Technician Qualifications and Submittal Requirements:
1. Technician list detailing pertinent experience and education, names, positions, length of service with vendor.
2. Location(s) of service centers to guarantee timely emergency response.

C. Input Device Types:
1. Air plenum temperature sensors shall be averaging type. Duct probes are only acceptable when installed in ductwork downstream of main plenum, or where sufficient mixing of sampled air is assured.
2. Motor run status shall be proved by analog current probes, and not by current-operated switches.
3. Main building supply/exhaust fans shall include air flow measuring stations reporting to EMS, with local (LCD) indication.

D. Output Device Types:
1. Valve and damper actuators shall be electric type with local manual override capability. Pneumatic actuation is only acceptable for large hydronic valves where electric actuation is not practical due to a high torque requirement.
2. Modulating electric control signal outputs shall be 0-10 or 2-10 VDC.
3. Primary operational controls (such as binary enable relay, analog actuator position, and analog speed reference signal) for variable frequency drives and other appliances shall be by means of hardwired output signals from the EMS controller. Gateway, BACnet, or other digital communication shall not be employed for control of equipment, even when data connections are present for other points such as equipment status or alarms.
4. Local H-O-A operation shall be possible without the use of portable electronic service tool for all field controls for pumps, fans, control valves, dampers, and solenoids.

E. Terminal Controls:
1. All terminal airflow controls shall transmit air flow rate to EMS.

F. Fire/Life Safety:
1. All automatically operated fire/smoke isolation dampers to include open/closed proving switches reporting to EMS, and preferably to Fire Alarm Control Panel (FACP) also.

G. Utility Metering:
1. Measure all utilities serving the building, including but not limited to electricity, plant chilled water, plant steam, plant condensate return, plant compressed air, natural gas, and city water:
   a. Provide meters that can display both instantaneous demand and total consumption.
   b. Provide meters that can record high/low/totalized and other historical data.
   c. Provide modern hardware that facilitates common industry network protocols, primarily Ethernet and BACnet, with some degree of flexibility.
   d. Provide a means of automatically logging and archiving long-term historical data for demand and consumption.
   e. Perform the site discovery necessary to determine the most efficient means of data transmission and storage. Provide monitors incorporating hardwired dry contact pulse (x10 kWh) and analog (0-10 VDC) outputs.
   f. Ensure that the system reliably logs data to removable media and has robust protection from power disturbances.
   g. All data to be archived by month/year in a .CSV compatible format.

2. Utility meters must transmit the following energy data to EMS:
   a. Chilled Water instantaneous demand in gallons per minute and in tons, and total consumption in ton-hours.
   b. Steam instantaneous demand in pounds per hour, and total consumption in pounds.
   c. Electricity instantaneous demand in kW, and total consumption in kWh.
   d. Natural gas total consumption in cubic feet.
   e. City water total consumption in gallons.
3. Metering ranges shall be selected with adequate turndown to guarantee accurate flow measurement at the lowest and highest normal anticipated flow rates.
4. All meters shall incorporate local display of both instantaneous rate and total consumption as transmitted to EMS.
5. Chilled water meter temperature sensors shall be factory-calibrated matched pairs with NIST certification, with provision for field calibration to at least 4 points within the working range.
6. All meters shall be factory-programmed for their intended use. Programmed parameters and calibration certificates shall be included in as-built submittals.
7. Metering shall be operational before utilities are activated to the building.
8. Resetting the totalized consumption of an energy meter shall be prohibited, allowable only by secure password or key.
9. Meter hardware selection shall be subject to Physical Plant approval.

H. Fume Hood Controls:
   1. Fume Hood airflow control shall incorporate flow setback based on occupancy.

I. Variable Frequency Drives:
   1. All VFDs shall have a mechanical ("3-contactor") bypass control. Electronic bypass controls are not preferred.

1.5 DOCUMENTATION

A. Original Submittals:
   1. Network Architecture Diagram shall depict all field and supervisory network devices, switches, gateways, protocols etc. with specific hardware/software details of the means of connection to new and existing components. Pre-bid discovery of existing network architecture and security features, and specific plan for communications is the sole responsibility of the controls contractor.
   2. A comprehensive air terminal Zone Schedule shall be provided in the project contract documents, with unique ID tag for each terminal. Typical/generic schedules are not acceptable. The terminal tags shall include designation of air handler system and floor. Each terminal listing shall indicate the associated Sequence of Operation ID#.
   3. Room numbering plan to be finalized and approved by occupants at start of project. In lieu of this, the EMS database, graphic displays, and as-built room schedule and drawings shall be revised after final room numbering is complete.
   4. The project contract documents shall specify the installed location for all field EMS sensors. All field coordination of sensor installation shall be made with reference to the documents. The controls contractor is responsible for coordination of sensor installation for the purpose of accomplishing the specified Sequence Of Operation.
   5. An index and samples of all planned graphical displays shall be submitted, and shall be subject to Physical Plant review and approval.
   6. All physical I/O points required to accomplish specified Sequence Of Operation to be tabulated in project contract documents. Point Matrix to include unique tags for each point, point types (AI, AO, BI, BO, Multistate), hardware types (ex. averaging sensor, current probe, indicating transmitter, spring return and fail position, gateway data, hardwired safety interlock etc.), local/remote override capability or HOA, and point descriptions with equipment or system assignments. Typical points for zone controls shall include a total quantity for each point type.

7. Process flow diagrams in the project contract documents shall graphically depict physical configuration of all I/O point tags as listed in Point Matrix. The documents shall cross-reference notes for field coordination on specifically named mechanical installation sheets, where permanent fixtures are needed such as temperature sensor wells, airflow measuring stations, actuated dampers, or gauge ports in main utility headers.
8. English language Sequence Of Operation in the project contract documents shall describe operation of all mechanical systems, processes, and interlocks with specific reference to all point tags as listed in Point Matrix. Zone control Sequences shall be numerically identified for listing in the terminal Zone Schedule submitted by the controls contactor. It is preferred that Sequences be accompanied by process programming flowcharts for clarity.
9. Project contract documents shall refer to design control ranges and pertinent control tolerances for commissioning benchmarks, and shall define allowable excursions for all controlled system variables. (Example: Office spaces controlled in the selectable range of 70 to 76 DEGF ± <1.5 DEGF from setpoint, temporary excursions permitted for degrees x minutes no more than 20 per hour) Consider ASHRAE published specs.
10. The controls submittal shall include planned conventions for point naming and descriptors in the EMS database, subject to review and approval by Physical Plant.
11. Preferred submittal formats:
    a. MEP drawings: one full-sized set of plans, plus the complete AutoCAD files (with all reference files).
    b. EMS as-built drawings: one 11x17 hard copy, plus an electronic version (PDF) or (original) Visio format.
    c. Operations & Maintenance (O&M) Manual: one hard copy, plus electronic version (PDF), to include all Startup and Commissioning reports.
    d. Test, Adjust and Balance Report: one hard copy, plus an electronic version (PDF).
    e. Framed control wiring diagrams with Sequence Of Operation: mounted as specified near all major equipment control panels. A bound copy inside the control panel instead of framed copies would be acceptable.
12. Submittal documentation subject to Physical Plant review.

B. As-Built Documents:
1. Network Architecture Diagram shall depict all field and supervisory network devices, switches, gateways, protocols etc. with specific hardware/software details of the means of connection to new and existing components. The physical installed route of all LAN communication cables shall detail the connection order of all devices, either graphically on a floor plan or by a comprehensive node-by-node list.
2. A Panel Schedule shall list all EMS field panels with a description or summary of installed components and physical location of each panel. Control power transformers shall be listed with power ratings. All panels and transformers shall be assigned unique ID numbers, and shall be field-labelled accordingly.
3. Physical locations of all panels, actuators, sensors, and other devices installed in concealed locations shall be clearly designated on scaled floor plans as part of EMS documentation (not on as-built mechanical drawings). Field labels per the Panel Schedule or Point Matrix tags should be unobtrusively marked on ceiling grids, hatches etc. near the location of the concealed apparatus (Installation spec).
4. The Point Matrix, Flow Diagrams, and Sequences shall all be updated to reflect final as-built configurations, terminal device ID numbers, room numbers, and point tag names.
5. Sequences Of Operation shall detail the location of particular processes in the EMS architecture. Each process shall be designated as occurring within the local equipment controller, or as part of a supervisory process, or by hardwired interlock, by operator override only, by supervisory panel schedule, by gateway data command, whether requiring local manual reset, etc. Narrative to be authored by programmer, not copied from Plans.
6. Local controller configuration files and other source files shall be backed up to an archive on removable media. Individual files with unique names matching the EMS device ID

numbers shall be created, downloaded, and backed up for all terminal control devices. Generic configuration files downloaded to multiple devices are not acceptable.

7. All controller configuration files and process control programs shall be completely documented in text form for reference.
8. A copy of the approved as-built wiring diagram for each field panel and controller shall be placed in the controls enclosures or otherwise affixed to the controller devices. Individual identical air terminals (zone controls) are excepted.
9. Product Data in the O&M Manual will include cover sheets with specific Model and Part ordering numbers as installed. Manual sections detailing non-installed parts or options shall be struck through or omitted.
10. As-built documentation subject to Physical Plant review and approval.

C. Test and Balance Report:
1. Equipment and zone designations shall match the ID tags as assigned in the project contract documents. IDs must be consistent between plans, manuals, EMS names and graphics.

D. Refrigeration Equipment:
1. Field startup reports for each direct-expansion and refrigeration system shall be provided as part of O&M documentation. Include unit designation from mechanical schedule, manufacturer model and serial number, fan and compressor actual RLA, type and actual quantity of system refrigerant charge and method of measurement (weighed in, estimated etc.), coil airflow data, evaporator and condenser differential temperature data, and operating pressure readings.

E. Variable Frequency Drives:
1. Field startup reports for each VFD shall be provided as part of O&M documentation. Include list of final settings for all programming parameters changed from factory default value. List input/output voltage and current and motor speed under normal load.

1.6 SYSTEM ARCHITECTURE

A. Theory of Operation:
1. All EMS software and firmware for terminal equipment control shall be resident in controller-level field hardware, except as needed for global strategies (such as scheduling) at the building supervisory controller level. Control of mechanical equipment physical outputs shall be accomplished via standalone logic at the application-specific controller level.
2. Input/output expansion modules shall be mounted in the same enclosure as their host controller.
3. Where control sequences of networked systems address life safety or critical equipment safety (such as high static pressure shutdown, or emergency generator mode when personnel entrapment is possible), hardwired controls with status reported to EMS shall be employed. Supervisory programming may not be used for critical or emergency controls.
4. Primary operational controls (such as binary enable relay, analog actuator position, and analog speed reference signal) for VFDs and other appliances shall be by means of hardwired output signals from the EMS controller. Gateway, BACnet, or other digital communication shall not be employed for control of equipment, even when data connections are present for other points such as equipment status or alarms.
5. VFD bypass function where provided shall be by means of mechanical 3-contactor bypass. Electronically controlled or automatic bypass switchover is not permitted. Local selection of manual bypass shall be reported to EMS.
6. Motor run status shall be proved by analog current probes, and not by current-operated switches.
7. All terminal airflow controls shall be electronic, and not pneumatic.
8. Connection of a portable workstation and controller upload/download capability shall be supported by a modular plug connection at each standalone controller, including a plug at each zone controller room sensor.

9. Any new EMS components shall be networked to the existing EMS network. Any revisions to Operator Workstation configurations or data shall be synchronized at ALL system workstations including laptops.

B. Operator Workstation:
   1. Operator workstation PC hard drive size must be 250 GB or larger.
   2. Configure system so that all archived historical data is saved on an external hard drive, NOT on the system drive.
   3. Configure system so that accumulated alarms or other historical data will not affect system performance, regardless of whether data is manually deleted or archived by an operator.
   4. It is the sole responsibility of the controls contractor to establish communication of new EMS components with the existing campus system. Where hardware, support, or coordination from campus IT staff is required, pre-bid discovery shall identify specific scope and estimated time required for all coordination.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION DETAILS

A. Safety Devices:
   1. Safety shutdown devices requiring manual trip reset shall be mounted in the controls Field Interface Panel (FIP) for the associated equipment, trip alarm shall be clearly annunciated with visual indicator at FIP, and EMS input shall be designated as Local Manual Reset type in O&M documentation, EMS database, and graphic displays.
   2. All safety shutdown devices shall be discretely wired to the FIP wiring terminal board for the associated equipment. Series wiring between field devices (high static cutouts, freezestats, door interlocks etc.) is not permitted. Safety devices shall not be located inside air plenums.
   3. Where fans are capable of producing duct static pressure approaching the burst rating of ductwork or accessories, a manual reset high static cutout switch shall be provided in the FIP with local visual indication, the safety device contacts shall directly interrupt the high voltage motor starter circuit, and alarm notification shall be sent to the EMS via auxiliary contacts.
   4. High static cutouts or other safeties requiring manual reset shall be located and clearly labelled in the equipment's controls enclosure (FIP). Trip condition shall be displayed by indicator light or other obvious means at control panel cover.
   5. Operation of equipment by the Fire/Smoke Control System (FSCS) or other Life Safety control shall only be by means of contact closure in a FSCS device interrupting a high voltage equipment starter circuit, with status reported to EMS via auxiliary contacts. EMS outputs shall not be the primary means of equipment.
   6. Steam safety relief valves shall be equipped with an EMS sensor for exhaust vent temperature.

B. Field I/O Devices:
   1. Where air static pressure is sensed at a location remote from the FIP, sensing tips shall be clearly labelled and mounted in an accessible location recorded in the as-built documents, and the sensing lines extended back to the location of the electronic pressure transmitter inside the FIP. Field-mounting of remote air pressure transmitters is not permitted.
   2. Install all pressure transmitters with valved blank gauge ports on high and low sensed lines to permit in-service calibration of transmitter. Include isolation valves to enable replacement of the sensor without relieving system pressure.

3. Space temperature sensors shall be permanently labelled with the EMS zone network ID and the zone tag number from the master schedule.
4. The project contract documents shall specify the installed location for all field EMS sensors. All field coordination of sensor installation shall be made with reference to the documents. The controls contractor is responsible for coordination of sensor installation for the purpose of accomplishing the specified Sequence Of Operation.
5. EMS field I/O devices shall have a permanent label attached listing point tag name from the project contract documents (Point Matrix), description, fail position where applicable, and calibrated input/output range.
6. Wiring from field controllers to remote sensors shall be labelled at both ends, or be readily distinguishable by color as per the wiring diagram.
7. Outside air sensors shall be located out of all direct sunlight, in a well-ventilated serviceable location not influenced by local factors such as machinery, exhaust air, or rooftop radiant heat.
8. Controls for terminal equipment mounted in ceiling spaces shall be installed so that all devices are serviceable from a single ladder location, including controller, power supply, flow sensor, damper actuator, control valve, isolation valves, and sensors.
9. Field-verify accuracy of actuated damper positions, and indelibly mark linkage and indicate "open" rotation. Preferred method is scoring a slot on the damper rod end; removable indicators marker are not considered indelible.
10. Electric actuators to be mounted to permit direct visual inspection of cover from service ladder with minimum 24 IN clearance in front.
11. Safe and reasonable access shall be provided to all field EMS devices without causing undue disruption of occupant activities, including where mechanical installations may need revision to maintain serviceability of devices.
12. Hydronic valve actuators to be mounted with actuator between 12:00 and 3:00 position (actuator must be above valve).

C. Field Panels:
1. Input/output expansion modules shall be mounted in the same enclosure as their host controller.
2. Install all electronic equipment according to manufacturer's recommendations for ambient conditions. Outdoor control enclosures must be ventilated with a source of conditioned air under positive pressure. Cabinet heaters or other controls shall be provided where unregulated panel cooling could cause condensation on circuitry. Filtered outside air is not acceptable for cooling of electronic controllers or VFDs.
3. Where conditioned air is not readily available for ventilation of VFDs or electronic controllers, and when devices cannot be relocated to a more suitable environment, the installing contractor shall be responsible for initiating remediation as necessary to protect the installed devices.
4. VFDs installed in enclosures shall be mounted with clearance on all sides as specified by the manufacturer. Basic operating status should be visible without opening the panel cover.
5. Panels in concealed spaces to be mounted to permit cover door swing and direct visual inspection of installed components from service ladder with minimum 24 IN clearance in front.
6. Terminal airflow controllers and devices shall be installed in a manner that does not obstruct the equipment's factory data tag. If this is impossible, a duplicate tag shall be provided.
7. A local power supply disconnect toggle switch shall be provided for all controller power supplies.
8. All control panel wiring terminations from field devices shall be made on numbered terminal strips per the wiring diagram. Wire nuts and crimped splices are not permitted in low-voltage control panels.

D. Field Panel Labelling:
   1. Each FIP shall be permanently labelled with its unique EMS network node ID, electrical power source circuit designation as per Division 26, and name or description of served equipment.

3.2 PROGRAMMING

A. Operator Workstation:
   1. The EMS vendor shall purchase the latest versions of controllers and software available at the time that the EMS contract is awarded. Compatible software at the same revision shall be installed on at least two workstations located in the Central Utility Plant and on at least two portable computers.
   2. Individual configuration files with unique names matching the EMS device ID numbers shall be created for all terminal control devices. Generic configuration files downloaded to multiple devices are not acceptable.
   3. Backup copies of source code shall be saved on the workstation for all control programs downloaded to field panels.

B. Database Details:
   1. Point naming shall be assigned consistently to facilitate global information retrieval. Where status of groups of similar points cannot be easily retrieved by filtering names, custom reports or displays shall be configured to permit an operator to display with a few keystrokes:
      a. All points presently overridden by operator command.
      b. All points presently in alarm state.
      c. All points presently in failed state.
      d. All room temperatures for a particular air handler system.
      e. All fan run statuses.
      f. All fan discharge air temperatures and static pressures.
      g. All pump run statuses.
      h. All hydronic supply/return temperatures and differential pressures.
      i. All fan airflow rates.
      j. Total zone heating demand for a particular air handler system.
      k. Total zone cooling demand for a particular air handler system.
      l. Status of all critical safeties and fire/smoke inputs.
   2. All points and device instances in the EMS database shall include a descriptor. The building and system assignment of all device instances shall be indicated when generation of a single report retrieves similar data from multiple buildings.
   3. The project contract documents must require Physical Plant approval of point naming convention before acceptance of controls submittals.
   4. Each controlled system shall be programmed with a binary "ENABLE" data point for scheduling and overriding. The ENABLE point shall initiate pre-programmed orderly startup and shutdown of all components in a system (EXAMPLE: all pumps, valves, and processes for the Heating Water System).
   5. Controller LAN addressing and device instance naming should match terminal node ID numbers per the project contract document mechanical schedule tags as much as possible. Do not number controllers to match room numbers. (EXAMPLE: zone terminal VAV1-2-101 is on AHU1 system, Floor 2, LAN address 101.) Room numbers should appear in editable controller Description field, but NOT in permanent device name.
   6. Temperature/pressure setpoint reset schedule parameters shall be available as point data at the Operator Workstation, allowing X-Y parameter adjustments by operator command without penetrating to the controller programming level.
   7. Alarm limits for analog inputs shall apply by default with reference to deviation from setpoint, not per preset values. Alarm states must be disabled when systems are not programmed to run, such as ignoring zone temperature alarms when the air handler is

scheduled off. Alarms shall only be re-enabled after an appropriate delay following system startup.

8. All programmed logic for terminal equipment control shall be resident (standalone) in controller-level field hardware, except as needed for global strategies such as scheduling at the building supervisory controller level.
9. Unless otherwise specified, room temperature setpoint adjustments by occupants should be limited from 70 to 76 DEGF.

C. Graphic Displays:
1. All equipment monitored or controlled by EMS shall be depicted graphically as per the as-built documentation flow diagrams. System layouts should approximate physical layouts. All system ENABLE points and physical outputs shall permit operator override by command from the display. Overridden points shall be flagged on the display.
2. The EMS Vendor shall work with Physical Plant to create displays that will show on single "summary" screens the values and status of point groups to include:
   a. All fan run status points and duct static pressures.
   b. All main air handler cooling/heating demands and valve positions.
   c. All chilled water system points.
   d. All heating water system points.
   e. All zone reheat valve commands (% open).
   f. All VAV damper commands (% open).
   g. All fume hood sash height positions.
   h. All fume hood occupancy states.
   i. All fume hood exhaust flow rates (CFM).
3. Color shall be used sparingly in system displays, to accentuate the use of the following colors to depict point status:
   a. ORANGE = overridden by operator.
   b. RED flashing = fire/life safety or other critical alarm.
   c. YELLOW = warning.
   d. WHITE, BLACK, GREY = normal or failed text.
   e. BLUE / RED = cool / warm indicator, setpoint deviation.
4. Analog devices should be shown as round symbols, and binary devices should be shown as square symbols.
5. Override command symbols shall be shown in an obvious and consistent manner for all points capable of being overridden.
6. Graphic displays of lab ventilation zones shall show all points for both supply and exhaust airflow controls on the same display.
7. EMS graphical displays of terminal zones shall employ UCR standards:
   a. Scaled floor plans including ALL as-built room numbers.
   b. For each terminal zone, show thermostat location and extent of served area by shading (e.g. shades of blue for AH3, shades of green for AH4) or other means.
   c. For each terminal zone, indicate associated air handler system by color (e.g. all AH3 zones blue, all AH4 zones green).
   d. Display room temperature and active setpoint.
   e. Room temperature alarms per deviation from active setpoint.
8. All graphical displays shall be integrated into a navigable system. Each screen shall include a navigation link to return to a Main Menu screen, and links for each major category of equipment (AHUs, CHW, HHW, Floor Plans, Alarms etc.).

D. Lab Airflow Control Systems:
1. The Lab Airflow Control System (LACS) shall display the following information for each supply/exhaust valve:
   a. Makeup air (CFM).
   b. General exhaust air (CFM).
   c. Hood exhaust air (CFM).
   d. Hood sash height (INCH) for each hood.

e. Occupancy status for each hood.
f. Flow alarm status.
g. Command - feedback mismatch.

2. Display of system data broadcast by the LACS shall comply with EMS naming convention.

E. Zone Occupancy Controls:
1. Terminal zone controls shall incorporate unoccupied setback of temperature and airflow setpoints. Initial occupancy schedule groups shall be programmed as directed by Physical Plant.

3.3 COMMISSIONING

A. Owner Training:
1. A Syllabus for owner in-service training at project end is required as part of original submittal for all new buildings and major renovations of existing buildings.
2. Specify videotaping only where necessary to illustrate to Operations staff the location of services or equipment which will not be readily accessible after construction is complete (Examples: sensors inside BSL3 areas, high voltage current transducers, slab sensors, confined spaces.). Training sessions need not be videotaped.
3. O&M Manual shall include a Controls System Manual for Building Operators. Contains descriptive summary of project and its controlled systems as installed. Gives specific description of each controlled system's hardware and control system. Lists main operating parameters, point names and override instructions for critical controls, typical or expected parameters and conditions, and basic navigating directions for front-end user interface. All information in the System Manual shall be uniquely written for the specific project's as-built condition, based on information from the controls contractor's startup programmer(s) and technician(s) at time of project completion.
4. In-service training syllabus for building operators shall include but not be limited to:
a. Show locations of all control panels and concealed devices.
b. Demonstrate modes of building operation via operator workstation interface.
c. Demonstrate operator overrides.
d. Demonstrate trend setup and data retrieval.
e. Simulate alarms.
f. Review all Sequences Of Operation.
g. Review as-built records.
h. Demonstrate controller upload/download/archive procedures.
i. Basic field controller and transmitter troubleshooting procedures.
j. Demonstrate use of portable field service tool(s).
5. O&M Manuals shall be delivered to Physical Plant prior to scheduling training sessions on relevant equipment.

B. Utility Metering:
1. Meters shall be installed, calibrated, operational, and communicating with the building's EMS system prior to turning on the metered utility to the project.
2. Any utility serving the facility during the construction period must be metered and logged beginning on the day the utility is first turned on. A Physical Plant representative will verify that the meter is commissioned before the utility is left on. The meters' reset functions will be disabled until final project completion.

END OF SECTION

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SECTION 26 00 10
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Electrical General Requirements, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

C. Concrete Anchoring:
1. Cracked concrete is the baseline condition for the design of cast-in-place and post-installed anchors in alignment with both ACI 318 and International Building Code.

D. Drawing Use and Interpretation:
1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except:
   a. Specific installation details.
   b. When specific dimensions are indicated for electrical equipment it is intended that these be limiting dimensions. When proposed equipment exceeds these limiting dimensions, advise Architect. Features and functions of specified equipment shall not be superseded by these limiting dimensions.
2. Field measurements take precedence over dimensioned drawings.
3. Intention is to indicate size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.

1.2 SYSTEM DESCRIPTION

A. Provide materials to provide systems in compliance with performance requirements specified.

B. Provide modifications required by reviewed shop drawings and field coordinated drawings.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with but not limited to:
1. Federal, state and local codes, regulations and ordinances.
2. Underwriters Laboratories, Inc. (UL) requirements.
3. NFPA-70 National Electrical Code (NEC).
4. California Electrical Code (CEC).
5. Occupational Safety and Health Act (OSHA).
6. All authorities having jurisdiction.
7. Factory Mutual System (FM) requirements.
8. International Building Code (IBC).
9. ACI 318: Building Code Requirements for Reinforced Concrete.
10. California Building Code.
11. State of California Administrative Code.
12. NFPA-45: Fire protection for laboratories using chemicals.
13. NFPA-101: Life safety code.
14. NFPA-110: Emergency and standby power systems.
15. ANSI/ASME-A17.1: Elevator code.
16. California Fire Code
17. ASHREA 90.1
18. USBGC LEED
19. IES Lighting Handbook 10th edition
20. UC Riverside Standards

B. Comply with Section 26 05 48 for seismic bracing of suspended components and equipment anchorage.

1.4 SUBMITTALS

A. Product Data:
   1. Concrete Anchors:
      a. Document Manufacturer Approval or Listing for cracked concrete application
         1) Drop-in anchors are not cracked concrete rated.

B. Contract Closeout Information:
   1. Final performance test reports.

1.5 PROTECTION

A. Provide covering and shielding for equipment to protect from damage.

B. Protect nameplates on motors and similar equipment, to prevent defacing.

C. Repair, restore or replace damaged, corroded and rejected items.

1.6 JOB CONDITIONS

A. Examine Contract Documents to determine how other work will affect execution of electrical work.

B. Make arrangements for and pay for permits, licenses, and inspections.

C. Cause as little interference or interruption of existing utilities and services as possible.
   1. Schedule work which will cause interference or interruption in advance with Owner, Architect, authorities having jurisdiction and affected trades.

D. Determine and verify locations of existing utilities on or near site.

E. Temporary construction power and communications (See Division 01)

F. Record drawings:
   1. Keep a complete set of electrical drawings in job site office for indicating actual installation of electrical systems and equipment.
   2. Use this set of drawings for no other purpose.
   3. Where any material, equipment, or system components are installed differently from that indicated, indicate differences clearly and neatly using ink or indelible pencil.
   4. At project completion, submit record set of drawings. Refer to Section 01 78 39 for specific requirements.

1.7 ENVIRONMENTAL CONDITIONS

A. General:
   1. Provide NEMA 1 enclosures for electrical equipment unless otherwise indicated.

B. Conduit: See Section 26 05 33.

C. Cable: See Section 26 05 19.

D. Boxes and Fittings: See Section 26 05 34.

E. Damp and Wet Locations:
   1. Exterior applications:
      a. Provide NEMA 3R enclosures for electrical equipment.

F. Corrosive Environments:
   1. Use NEMA 4X reinforced fiberglass watertight enclosures in areas with corrosive atmospheres.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Concrete Anchors:
   1. Hilti
   2. Simpson Strong-Tie
   3. Powers Fasteners

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Concrete Anchors:
   1. Cast-in-place or post installed anchor approved for cracked concrete applications.
      a. Note; Drop-In Anchors SHALL NOT be used.

B. Material and Equipment:
   1. Current and standard design of manufacturers regularly engaged in their production.

C. Where UL approval or listing is required in electrical specifications, suitable approval or listing from other nationally recognized testing laboratory (NRTL) is acceptable.

D. Use UL labeled electrical materials and fabricated assemblies.

E. Structural Steel for Supports:
   1. ASTM A36.
   2. Galvanize members installed in areas of high humidity or condensation.
   3. Furnish other members with shop coat of rust inhibiting primer.
   4. Shop fabricate for field assembly using bolts.
   5. Minimize field welding.
   6. Retouch primer and galvanizing after field welding.
   7. Unless support is otherwise indicated where weight of equipment exceeds 400 LBS, submit engineering design and calculations signed and sealed by a registered Engineer licensed to practice Structural Engineering in the state in which the project is located.

F. Rain Hoods and Counter Flashings, not exposed to view:
   1. Stainless steel: Minimum 20 GA.
   2. Sheet copper: Minimum 24 OZ.

G. Rain Hoods and Counter Flashings, exposed to view:
   1. See Section 07 62 00.

H. Access Doors, Panels and Frames:
   1. Provide where indicated on Drawings.
   2. Where not indicated on Drawings, provide access panels and/or doors at walls, and inaccessible ceilings as required to permit access to equipment, devices and piping requiring service, adjustment, or inspection.
   3. Size:
      a. As required to allow access, inspection, service, and removal of items served.
      b. Minimum 18 x 18 IN.

I. Concrete Anchors:
   1. Cast-in-place or post installed anchor approved for cracked concrete applications.
      a. Note; Drop-In Anchors SHALL NOT be used.

2.3 FIRESTOPPING

A. Maintain fire and smoke ratings where electrical items penetrate fire and fire/smoke rated building elements.

B. Use materials and methods as specified in Section 07 84 00.

PART 3 - EXECUTION

3.1 GENERAL

A. When changes in location of any work are required, obtain approval of Architect before making change.

B. Do not change indicated sizes without written approval of Architect.

C. Provide offsets and crossovers in conduits, raceways, cable trays and ducts.

D. Where electrical items penetrate fire and/or smoke rated walls, ceilings and floors, comply with Section 07 84 00.

3.2 CUTTING AND PATCHING

A. Provide cutting, fitting, repairing, patching and finishing of installed work.
   1. Include installed work of other sections where it is to disturb such work to permit installation of electrical work.
   2. Repair or replace existing or new work disturbed.

B. Avoid cutting, where possible, by setting sleeves or frames, and by requesting openings in advance.

C. Before cutting, obtain approval of Structural Engineer.
   1. Use only approved methods.
   2. Cut holes approved by Engineer neatly to admit work.
   3. Do not weaken walls or floors; locate holes in concrete to avoid structural members.

D. Locate openings and sleeves to permit neat installation of conduits and equipment.

E. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace fireproofing removed or damaged, at no extra cost.

F. See Section 01 73 29.

3.3 EXCAVATING AND BACKFILLING

A. Excavating, trenching, and backfilling:
   1. See Section 26 05 43.

3.4 INSTALLATION OF EQUIPMENT

A. Install equipment in accordance with manufacturer's recommendations.

B. Anchoring Devices and Supports.
   1. Use anchoring devices and structural supports suitable for equipment and install in accordance with manufacturer’s recommendations.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.
   4. Provide equipment supports even though not detailed on architectural and structural drawings.

C. Brace and anchor equipment in accordance with Section 26 05 48.

D. Verify equipment will fit support layouts indicated.

E. Provide boxes, sleeves and devices for installation.

F. Make penetrations through roofs prior to installation of roofing.

G. For penetrations required after installation of roofing:
   1. In built-up roofing (BUR), provide curbs, cants and base flashings.
   2. In elastic sheet roofing (ESR), arrange and pay for flashing work by authorized roofer.

H. Install rain hoods and metal counter flashings as indicated and make penetrations of electrical work through walls and roofs water and weathertight.
   1. Furnish clamps, waterproofing material and labor.
   2. Where metal flashings are applied over concrete, paint concrete with 1/8 IN of mastic cement first.
   3. Set flashing in mastic cement, watertight.

I. Have repair and replacement of roof construction, damaged by this work, done in manner which will not nullify roof warranty.

J. Install equipment to permit easy access for normal maintenance.
   1. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.
   2. Relocate items which interfere with access.

K. Provide concrete foundations (isolation pads) or housekeeping pads for floor mounted electrical equipment as follows unless otherwise indicated:
   1. Install nominal 4 IN high concrete housekeeping pads. Outside dimension of pad shall be at least 4 IN larger in all directions than base of equipment or 228 MM 9 IN from center of anchor, whichever is greater.
   2. Use 3,000 PSI concrete.
   3. Reinforce with No.4 12 IN OC each way, with short No.4 dowels into floor at 24 IN OC each way.
   4. Chamfer top edges 3/4 IN.
   5. Make faces smooth.
   6. Set anchor bolts for equipment.

3.5 PAINTING

A. See Section 09 91 13 and Section 09 91 23.

3.6 REMODELING

A. Field verify locations and arrangement of existing systems and equipment.

B. Where relocation of existing equipment and piping systems is necessary in areas providing services that must remain in operation, schedule work for minimal down time during slack period.
   1. Anticipate scheduling work during premium time and include cost in proposal.

C. Do not cut into existing services without first verifying with Owner that service has been correctly identified.
   1. Perform work that interrupts any service during premium time.
      a. Include cutting into existing lines for new connection.
      b. Cause least interference to normal operation of building.
   2. Inform building engineering staff in advance of any shut off that will occur and give estimate of duration.
   3. Begin work only after engineering staff is fully informed and has agreed to schedule of shut offs.

D. Fabricate and install interconnecting portions of these systems prior to shut down for final connections.

E. Maintain existing services and equipment unless indicated to be removed.

F. Perform demolition as directed by Contractor.
   1. Remove equipment indicated.
   2. Relocate items indicated after thorough cleaning.
   3. Remove existing wiring serving abandoned circuits.
   4. Remove non-embedded conduit serving abandoned circuits.

G. Salvage items in accordance with Section 02 41 00.

H. Existing conduit and wire of proper sizes may be spliced and extended from appropriate points, but do not reuse after removal.

I. Existing equipment and materials removed from existing construction and not indicated or required to be reused shall become the property of the Owner, if they so elect.
   1. Present equipment and materials removed to Owner's representative, who shall select equipment and materials to retain.
   2. Equipment and materials not retained shall become property of Contractor and shall be removed from site.

3.7 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
   1. Acceptance testing shall be performed in accordance with NETA Acceptance Test Specification (ATS), latest revision, and will include applicable sections for electrical equipment installed. Tests are required to be performed by an approved third-party testing laboratory or shall be made by a lab acceptable to the University. NETA membership or A2LA accreditation is minimum selection criteria for laboratory competency.
   2. Conduct tests in presence of Architect and, if required inspectors of agencies having jurisdiction.
   3. Arrange date of tests in advance with Architect, manufacturer and installer.
   4. Give minimum of 24 HRS notice to inspectors.
   5. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.
   6. Furnish lubricating materials required for test.

B. Repair or replace equipment and systems found inoperative or defective and retest.
   1. If equipment or system fails retest, replace it with products conforming with Contract Documents.
   2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

3.8 FINAL PERFORMANCE TEST

A. Perform panel load balance, short circuit, and freedom from ground, and ground test (including ground fault protection where provided).
   1. As part of putting systems in operation, provide tabulated results of load balance and voltage at each switchboard, panelboard and motor control center. Use true RMS measuring metering devices.
   2. Provide written report that circuits have been energized and no short circuits exist.
   3. Provide neutral to ground resistance tests to prove neutral is grounded in only one location.
   4. Provide ground test at service entrance and provide report on resistance to earth of the grounding electrode system.

3.9 ADJUST AND CLEAN

A. Inspect equipment and put in good working order.

B. Clean exposed and concealed items.

C. Where new work occurs in existing areas where no other work has been done, clean area and restore to original condition.

3.10 PUTTING SYSTEMS IN OPERATION - START UP

A. Put systems into satisfactory operation prior to final acceptance, at time agreed to by Contractor, Owner and Architect.

B. Operate systems in good working order for period of 5 working days.

3.11 DEVICE MOUNTING

A. See symbol legend for devise mounting heights unless otherwise noted.

B. Dimensions are to center of device unless otherwise indicated.

C. Coordinate device locations with equipment/furnishings abutting walls such as, but not limited to, architectural millwork, casework, lockers, mirrors, and equipment. Refer to architectural and casework/equipment elevations to facilitate coordination of device placement. Devices shall be relocated at Contractor's expense if conflict exists after installation.

D. Coordinate device mounting height with wainscoting where provided. Where top of wainscot and device mounting height overlaps, shift device down to provide 2 IN gap between top of device and top of wainscot.

END OF SECTION

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SECTION 26 00 11
WIRING EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish conduit, wiring, outlet boxes, receptacles, circuit breakers, fittings, switches, starters, (with overloads), to make final connections to equipment.

B. Connect:
1. Elevator equipment, (Division 14).
2. Heating, ventilation, cooling and plumbing system equipment, (Divisions 22, 23, 25).
3. Automatic door equipment, (Division 08).
4. Projection screens, (Division 11).
5. Fixed and/or movable equipment, (Division 11).
6. Systems furniture (Division 12).
7. Electronic security equipment, (Division 28).

C. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Elevator:
1. Provide following for each elevator:
   a. Fusible switch:
      1) Locate on wall or fabricated rack near door of machine room.
      2) Furnish conduit and wire from switch to controller.
   b. 30 A S/N, 120V disconnecting switch for 120V power supply for car lights.
      1) Locate adjacent to elevator fusible switch.
   c. 120V GFCI duplex receptacle and vapor-tight fixture in each elevator pit, with switch and pilot light located outside of pit at 48 IN above floor. Pit light shall not be protected by GFCI.
   d. 120V GFCI duplex receptacle in each elevator machine room.
   e. 120V single receptacle mounted in pit for sump pump.
   f. Provide NEMA 3R equipment in elevator machine room if room is sprinkled.
   g. Car telephone outlet J-box with empty 3/4 IN conduit to telephone cabinet.
      1) Locate at midpoint of each shaft or at elevator controller as directed by elevator installer.
2. See section 28 31 13 for connections to Fire Alarm System.
3. Coordinate controls connection to automatic transfer switches serving elevators. See specification 26 36 23.
4. The shunt trip breaker for each elevator shall be a UL listed device with shunt trip voltage isolation relay monitored by the fire alarm system in accordance with NFPA 72. Shunt trip disconnect for elevator shall be rated for use in wet location if elevator machine room is sprinkled.

B. Mechanical Specification Divisions Equipment:
1. Furnish conduit, wire, and connect Mechanical Specification Divisions equipment.
2. Furnish motor starters except in package or prewired units as indicated in Mechanical Equipment Schedule.
   a. Connect motors.

b. Furnish starters with thermal overload protection for motors not having such protection, except as otherwise indicated.

3. Furnish proper thermal overload heater elements in starters.
4. Coordinate all equipment shutdown emergency power off (EPO) switch requirements with Mechanical/Controls Contractor.
5. Provide connection to all air handling unit internal receptacle, lighting, and UV germicidal circuits. Coordinate interconnections within unit with Mechanical Contractor.
6. Smoke and Fire/Smoke Dampers:
   a. Provide power connection to all smoke and fire/smoke dampers. The Contractor shall utilize the 120V Emergency circuits shown on the drawings for this purpose. Total load on each circuit shall not exceed 1200VA upon actuator operation.
   b. Each damper shall include a local disconnecting means.

C. Automatic Door Equipment:
1. Furnish conduit, wiring, outlet boxes to make final connections to motors, switches, safety mats, proximity detectors, remote control units, electric dead bolts.
2. See Section 28 31 13 for connections to fire alarm system.
3. Switches for control of automatic doors provided by door manufacturer, installed by electrical.

D. Projection Screens:
1. Furnish conduit, wiring, outlet boxes to make final connections to power projection screens and associated UP/STOP/DOWN switches.
2. UP/STOP/DOWN switches provided by door manufacturer, installed by electrical.

E. Division 11 Equipment:
1. Furnish conduit, wiring, outlet boxes, receptacles, circuit breakers, fittings, switches, to make final connections to equipment.
2. Where equipment items are to be connected using plug and receptacle, furnish receptacle compatible with plug.
3. Where equipment is to be directly connected, use flexible conduit as indicated in Section 26 05 33.
4. See Division 11 and electrical plans for equipment to be connected.

F. SYSTEMS FURNITURE
1. Provide power connection to pre-wired systems furniture. Coordinate final connection requirements.
2. Coordinate circuit breaker for circuits feeding systems furniture with systems furniture internal wiring. If a shared neutral is provided within the systems furniture, a multi-pole circuit breaker of appropriate ampacity shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Perform work in accordance with applicable Electrical Specifications Divisions.

B. Wire equipment complete, properly connected and energized.

C. Furnish conduit and wiring as required for directly-connected switches as indicated or required.

END OF SECTION

SECTION 26 05 13
MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Medium Voltage Cables, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. EPR insulated cable shall comply with the following:
   1. NEMA Publication No. WC 74-2006, ICEA Publication S-93-639, 5-46 kV Shielded Power Cable for Use in the Transmission & Distribution of Electric Energy,
   2. AEIC (Association of Edison Illuminating Companies) Publication No.CS8-07, Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 KV
   3. UL1072 Medium Voltage Power Cables.

B. Splices and terminations shall comply with the following:
   1. IEEE 404-2006 IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 to 500000 V
   2. IEEE 48- IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV.

C. Factory Tests:
   1. Each reel of cable shall be tested in accordance with requirements of:
      a. ICEA-S-93-639 including but not limited to following tests:
         1) Electrical resistance.
         2) Insulation resistance.
         3) High voltage a.c. and d.c potential.
      b. AEIC-CS8-07 including but not limited to following test:
         1) Corona.
   2. Factory test data and certification of compliance shall be submitted.

D. High potential testing shall comply with the following:
   1. IEEE 400-2001 IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
   2. InterNational Electrical Testing Association (NETA)- Acceptance Testing Specifications For Electrical Power Distribution Equipment and Systems.

E. Qualifications:
   1. Cable technician:
      a. Fifteen years experience in handling, terminating and splicing medium voltage cables.
      b. Specifically trained by factory representative on terminations and splices to be used on project. If not trained on products to be used, on-site training by factory representative shall be preformed before any terminations or splices are made.
   2. Cable testing :
      a. Independent testing organization shall have been engaged in full practice in final inspection, testing, calibration, and adjusting of electrical distribution systems, for minimum of five years.
      b. Testing shall be performed by individual who has had at least 5 years experience in testing of medium voltage cables of this type with specified testing procedure.

c. Independent testing organization shall have calibration program with accuracy traceable every six months in unbroken chain, to National Institute of Standards and Technology (NIST).
d. Independent testing organization shall have designated safety representative on project. Standards followed shall include OSHA, NFPA 70E and IEEE 510.
e. Inspection, testing, and calibration shall be performed by engineering technician, certified by national organization, such as InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, with minimum of five years experience inspecting, testing, and calibrating electrical equipment, systems and devices. Information on certified engineering technician shall be submitted to Engineer for approval prior to start of work.
f. Qualifications of independent testing organization shall be submitted to Engineer for approval prior to start of testing. Full membership to InterNational Electrical Testing Association constitutes proof of meeting all above requirements.

1.3 SUBMITTALS

A. Product Data:
1. Technical data on each type of cable, splice and termination.

B. Samples:
1. Cable sample:
a. Length submitted to include all stamped on information including:
1) Manufacturers name.
2) Plant number or designation.
3) Conductor size.
4) Copper.
5) Voltage rating.
6) Insulation type and level.
7) Insulation thickness.
8) UL designation.
9) Type MV-105.

C. Project Information:
1. Factory test reports.
2. Cable Technician qualifications.
3. Independent testing organization qualifications.
4. Engineering Technician qualifications.
5. Cable pulling tension record from pulling rig dynamometer.
6. Cable test reports signed by the engineering technician including the following information:
a. Summary of Project.
b. Description of equipment/components tested.
c. Visual inspection report.
d. Description of tests.
e. Test results including appropriate test forms.
f. Conclusions and recommendations.
g. Identification of test equipment used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Medium voltage cable:
1. Base:
a. Okonite.
b. Kerite.

c. Southwire.
d. Prymian Cable.

B. Splices and terminations:
1. Base:
a. Elastimold
2. Other manufacturers desiring approval comply with Section 01630.

C. High dielectric, arc proof and insulating tape:
1. Base:
a. 3M.
b. Okonite.
2. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Medium Voltage Power Cable:
1. Medium voltage cable: Single conductor, copper, rated 105 DEGC wet or dry, EPR, 133 PCT insulation level, Type MV-105.
a. 15 kVrated, 220 MIL average thickness.
2. Cable shall be no more than 12 months old and each reel shall have label indicating name of manufacturer and date of manufacture.
3. Conductor: Compressed concentric round, Class B, stranded, annealed base copper.
4. Conductor shield: Free stripping layer of extruded semi-conducting EPR firmly bonded to the insulation.
5. Insulation: Ethylene Propylene Rubber (EPR).
6. Insulation shield: Free stripping layer of extruded semi-conducting EPR.
7. Shield: Helically applied 5 MIL uncoated copper tape overlapped a minimum of 12.5 PCT.
8. Outer jacket: Oil and sunlight resistant PVC.
9. Outer jacket: Oil, sunlight and flame resistant PVC rated for use in cable tray.
10. Armor: None.
11. Armor Jacket: None.

B. Splices and Terminations:
1. Splicing and terminating materials:
a. Acceptable to and as recommended by cable manufacturer.
b. Equal to or exceed rating of cable.
2. Splices: Cold shrink molded rubber or hot shrink manufactured kit type in accordance with IEEE 404 and suitable for water immersion.
a. Conductor splices: Compression type, long barrel terminals with minimum of three crimps.
b. Insulation, shield and jacket splices:
1) In-line splices:
a) Cold shrink molded rubber: 3M 5500 series.
b) Hot shrink, 5 kV: Raychem HVS 820S Series.
c) Hot shrink, 15 kV: Raychem HVS 1520S Series.
2) Wye splices:
a) Hot shrink: Raychem HVSY 1520S Series.
c. Splices: Deadfront, modular, separable insulated connectors in accordance with IEEE 386 and suitable for water immersion.
d. 200A loadbreak elbows and 2-way, 3-way and/or 4-way loadbreak junctions mounted on a stainless steel bracket.
1) Cooper Power Systems 500 Series.
3. Terminations:
a. Indoor: Cold shrink or hot shrink manufactured kit type in accordance with IEEE 48 Class 1 terminations utilizing high dielectric constant stress control tube:
1) Conductor termination: Compression type lug.
2) Insulation, shield, and jacket terminations:

3) Cold shrink: 3M 5620K Series.
4) Hot shrink, 15 kV: Raychem HVT-150-SG Series.

b. Outdoor or within exterior enclosures: Porcelain, cold shrink or hot shrink manufactured kit type in accordance with IEEE 48 Class 1 terminations utilizing high dielectric constant stress control tube:
1) Conductor termination: Compression type lug.
2) Insulation, shield, and jacket terminations:
3) Porcelain: 3M 5900 Series.
4) Cold shrink: 3M 5630K Series.
5) Hot shrink, 15 kV: Raychem HVT-150-SG Series.

2.3 ARC PROOF TAPE

A. Flexible, conformable, organic fabric coated one side with flame-retarded flexible elastomer; self-extinguishing; and shall not support combustion.

B. 3M Scotch 77.or Plymouth "Plyarc"

2.4 INSULATING TAPE FOR USE WITH ARC PROOF TAPE

A. Woven glass fabric with pressure-sensitive thermosetting adhesive.

B. 3M Scotch 69.

2.5 PULLING LUBRICANT

A. Pulling lubricant: Approved by cable manufacturer.

PART 3 - EXECUTION

3.1 CABLE PULLING

A. Do not install cable during wet conditions.
1. Prior to pulling cables, drain or pump out manholes and other low points if standing water is present.
2. Blow out conduits with dried compressed air if moisture is present in conduits.
3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
a. If end caps are damaged, remove and install new end caps.
b. Do not remove end caps until ready to terminate or splice cable.

B. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

C. Set up reels as close to duct entrance as possible.

D. Do not bend cable permanently or temporarily to radius less than 12 times cable diameter.

E. Provide cable protector at duct entrance.

F. Pull all cables occupying same conduit together.

G. Make attachment to cable to be pulled by woven basket grips or directly to conductor.

H. Use swivel connector.

I. Seal cable ends.

J. Use no pulling lubricant on first or last 5 FT of cable.

K. Pull cables slowly and steadily:
1. Do not exceed 50 FPM.
2. Stop only if absolutely necessary.

L. Maximum pulling tension on conductor not greater than smaller of following:
   1. Manufacturer's allowable tension.
   2. 0.008 LB/cm x cm for copper conductors when pulling eye is employed where cm is the circular mill area of single conductor, total area of the several conductors in a single cable, or the total area of conductors of all cables pulled at the same time.
   3. 5000 LB.

M. Tension on pulling devices not greater than the smaller of the following:
   1. Manufacturer's allowable tension.
   2. 1000 LB per grip when basket grip is employed.

N. Tension limiting side wall pressure not greater than the smaller of the following:
   1. Manufacturer's allowable tension.
   2. 300 LB per foot for radius of curvature.

O. Provide pulling rig with pulling tension indicating and recording dynamometer.
   1. Submit record of the actual pulling tension of each cable pull. Submittal shall indicating compliance with allowable pulling tension.
   2. Replace cables when actual pulling tensions exceeds the allowable pulling tension.

3.2 SPLICING AND TERMINATING

A. Install splices and terminations acceptable to the cable manufacturer and in accordance with the splice and termination kit manufacturer's instructions.

B. Splices and terminations shall be performed by qualified individual(s) with a minimum of 5 years of experience in splicing and terminating the same or similar types of cable, splices and terminations approved for installation.

C. Ground shield at each termination.

D. Ground shield at each termination and splice.

3.3 FIREPROOFING (ARC-PROOFING)

A. All cables in pull boxes, junction boxes, cable tray and manholes shall be arc-proofed. Irregularities of cable at splice shall be evened out with arc-proof tape. Each circuit shall be individually fireproofed.

B. Strips of fireproofing tape approximately 1/16 IN thick by 3 IN wide shall be wrapped tightly around each circuit spirally in one half-lapped wrapping, or in two butt-joint wrappings with second wrapping covering joints in first wrapping
   1. Tape shall be applied with coated side toward cables and shall extend one inch into ducts.
   2. To prevent unraveling, fireproofing tape shall be random spiral wrapped with pressure sensitive glass cloth tape.
   3. Fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymetric coating and/or chlorinated elastomer.
   4. Tape shall not be less than 0.050 in. thick and shall weigh not less than 2.5 LBS per square yard.
   5. Tape shall be non-corrosive to cable sheaths, shall be self-extinguishing, and shall not support combustion.
   6. Tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage or fungus.

3.4 TESTING OF CABLES

A. Factory test: See quality assurance paragraphs at beginning of this specification.

B. Field tests: Comply with following requirements:
   1. After all terminations and splices have been made, and prior to connections to equipment, provide following acceptance tests:
      a. Shield continuity test.

b. DC high potential tests.

2. New Cable:
   a. Tests shall be performed and submitted on new cable.
   b. Test new cable after installation, splices and terminations have been made but before connection to equipment and existing cables.
3. Existing Cables:
   a. Test shall be performed and submitted on existing cable interconnected to new cable.
   b. After testing new cable and connection to existing cable has been completed, test interconnected cable. Disconnect cable from all equipment that might be damaged by test voltages.
4. High Potential Test:
   a. Leakage current test shall be high potential D.C. step voltage method.
   b. Prior to high potential test, test cable and shields for continuity, shorts, and grounds.
   c. High potential test shall measure leakage current from each conductor to insulation shield. Use corona shields, guard rings, taping, mason jars, or plastic bags to prevent corona current from influencing readings. Unprepared cable shield ends shall be trimmed back one inch or more for each 10kV of test voltage.
5. Safety Precautions:
   a. Exercise suitable and adequate safety measures prior to, during, and after high potential tests, including but not limited to placing warning signs and preventing people and equipment from being exposed to test voltages.
6. Test Voltages:
   a. New shielded cable D.C. test voltages shall be as follows:

		Test Voltage kV	
Rated Circuit Voltage Phase-to Phase Volts	Wire Size AWG or MCM	100 Percent Insulation Level	133 Percent Insulation Level
2001-5000	2-1000	25	25
5001-8000	2-1000	35	35
8001-15000	2-1000	55	65

   b. Existing cable of all types interconnected to new cable shall be tested at 1.7 times existing cable rated voltage.
7. High Potential Test Method:
   a. Apply voltage in approximately 8-10 equal steps.
   b. Raise voltage slowly between steps.
   c. At end of each step, allow charging currents to decay, and monitor time interval of decay.
   d. Read leakage current and plot curve of leakage versus test voltage on graph paper as test progresses. Read leakage current at same time interval for each voltage step.
   e. Stop test if leakage currents increase excessively or "knee" appears in curve before maximum test voltage is reached.
      1) For new cable, replace cable and repeat test.
      2) For existing cable interconnected to new cable, notify owner for further instructions.
   f. Upon reaching maximum test voltage, hold voltage for five minutes. Read leakage current at 30- second intervals and plot curve of leakage current versus time on same graph paper as step voltage curve.
      1) Stop test if leakage current starts to rise, or decreases and again starts to rise. Leakage current should decrease and stabilize for acceptable cable.
   g. Terminate test and allow sufficient discharge time before testing next conductor.
8. Replace all cable that fails testing.
   a. Any cable which has terminations and/or splices which are suspected to have caused failure may be re-terminated and/or re-spliced and retested.

b. Second failure shall be cause for replacement.
c. In all cases where cable is questionable due to testing results, Architect/Engineer will determine replacement requirements.

9. Retest all replaced cable.
10. Submit complete test results.

END OF SECTION

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SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Low Voltage Electrical Power Conductors and Cables, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Splices and taps for smaller than No.6 AWG wire:
   1. Base:
      a. 3M.
      b. Ideal Electric.
      c. Heyco Molded Products.
      d. Elastimold.
      e. Buchanan Construction Products.
   2. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Wire for 600 volts and below: Single conductor, soft drawn, copper wire with 600 volt insulation, UL listed.
   1. For feeders and branch circuits: Type THWN/THHN or XHHW.
   2. For exterior feeder and branch circuits: Type XHHW.
   3. For branch circuits served by GFCI circuit breakers: Type XHHW.
   4. Use no wire smaller than No.12 AWG, except as follows:
      a. Smaller size wire may be used only where specifically indicated.
      b. No.14 AWG may be used for pilot control and signal circuits.
   5. Size conductors to match over current protective device unless larger conductors are indicated.
   6. No. 10 AWG conductor to be used for 20 ampere, 120V circuits exceeding 100 FT.
   7. No. 10 AWG conductor to be used for 20 ampere, 277V circuits exceeding 200 FT

B. Splices and taps for smaller than No.6 AWG wire:
   1. 3M, "Scotchlok" or "Hyflex".
   2. Ideal "Wingnut" or "Wirenut".
   3. Heyco.
   4. Elastimold insulated conical spring-type connectors.

C. Splices and taps for No.6 AWG wire and larger: Use compression connectors with prestretched insulation to equal insulation of wire being spliced.

D. Splices and taps - General: Do not make splices and taps with crimp or indenter-type connectors.

E. Pulling lubricant: Do not use cable pulling lubrication compound containing petroleum or other products which may deteriorate insulation.

F. Color coding: Color code all conductors in accordance with NEC as follows:
   1. Color code all wiring.
   2. Use following colors in lighting and power wiring:

	120/208 VOLT	277/480 VOLT
Phase 1	Black	Brown
Phase 2	Red	Orange
Phase 3	Blue	Yellow
Neutrals	White	Gray
Ground	Green	Green

3. Isolated equipment grounding conductor: Green with one or more yellow stripe(s).
4. Color coding of ends only will be acceptable for feeder phase conductors.
5. Color coding of ends only will be acceptable for neutral and grounding conductors number 4 AWG and larger.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting and receptacle home runs indicated are for identification purposes only.

B. Install all line voltage wiring in conduit unless otherwise indicated.

C. Install no more than 3 phase conductors in one conduit. This excludes ground wire. The neutral conductor shall be considered as a current carrying conductor.

D. Two or three branch circuits may be carried on one neutral leg as permitted by NEC. See Section 26 24 16 for circuits served by ground fault circuit interrupter circuit breakers.

E. Run panelboard and motor feeders in individual conduits.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Grounding and Bonding for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

A. Product Data:
   1. Technical data on connectors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Exothermic weld kits:
   1. Base:
      a. Cadweld.

B. Compression fittings:
   1. Base:
      a. Burndy.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Wire and Cable:
   1. See Section 26 05 19.
   2. Main ground: Copper conductor, sized as required by appropriate service grounding conductor table of NEC.
   3. Grounding copper conductor for non-metallic conduit and ducts: Copper bar or insulated conductor, sized in accordance with NEC or as indicated.

B. Conduit:
   1. See Section 26 05 33.

C. Grounding Clamp Connections:
   1. Clean contact surfaces, tinned and sweated during bolting.

D. Grounding Type Insulated Bushings:
   1. See Section 26 05 33.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground neutral conductors, conduit systems, cabinets, equipment, motor frames, etc., in accordance with NEC and applicable codes.

B. Locate neutral ground disconnecting link or links in main switchboard so that low-voltage neutral bar with all interior secondary neutrals can be isolated from common equipment grounding bus.

3.2 INSTALLATION

A. Main Ground:
   1. Install main grounding conductor in steel conduit and connect to grounding electrode system using an exothermic weld or UL listed compression fitting.
      a. Unless otherwise indicated, install main ground unspliced in exposed conduit.
      b. Make connections easily accessible for inspection, not underground or concealed in floors or walls.
      c. Provide grounding electrode system in accordance with NEC.
      d. Resistance to earth of the grounding electrode system shall not exceed 25 ohms.
   2. Bond grounding conductor to conduit at entrance and exit, of same type and quality as other conductors in building.
   3. Install grounding jumper of same size around water meter using ground clamps.

B. Wall Mount Busbars:
   1. Mount busbars plumb and anchor to securely to substrate in accordance with manufacturer's instructions.
   2. Complete conductor connections with 2-hole bolt-on compression lugs.
      a. Size to fit busbar and conditions.

C. Distribution:
   1. Make metallic raceway fittings and grounding clamps tight to insure that equipment grounding system operates continuously at ground potential.
      a. Provide low impedance current path to insure proper operation of overcurrent devices during potential ground fault currents.
   2. Do not solder grounding circuit connections.
   3. Where metallic conduits terminate without mechanical connection to metallic housing (switchboards, motor control centers, etc.), provide each conduit with grounding type insulated bushing.
      a. Connect each bushing to grounding bus in equipment with bare copper conductor.
   4. In nonmetallic conduits or ducts maintain continuity of equipment grounding system by bar or conductor installed and connected by approved method to conductive noncurrent-carrying equipment at both ends.
   5. Ground conduit, panel boards, receptacles, accessible fixtures, switchgear, transformers, motors and motor equipment.
   6. Make ground continuity positive throughout entire project.

3.3 TESTING AND FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Perform testing in accordance with test instrument manufacturer's recommendations.

C. Utilize approved Earth Ground Clamp Meter to test grounding and bonding system.
   1. Record results and provide to Owner prior to Project Closeout.

D. Test communication systems grounding and bonding with building systems in operation.

E. Measure effectiveness of bonding jumpers with clamp on meter to metal being tested to ground, or perform two point testing method (busbar to metal being grounded).
   1. If resistance is less than 0.1 Ohms between two test points, bonding is adequate.
   2. If resistance is greater than 0.1 Ohms between two test points, check connections and retest.
   3. Provide report of test to Owner.

END OF SECTION

SECTION 26 05 33
CONDUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Conduits, as indicated, in accordance with provisions of Contract Documents.

B. Conduit runs are diagrammatic. Verify and coordinate locations in field.

C. Completely coordinate with work of other trades.

1.2 SECTION INCLUDES

A. Rigid Metal Conduit (RMC).

B. Intermediate Metal Conduit (IMC).

C. Electrical Metallic Tubing (EMT).

D. Flexible Metal Conduit (FMC).

E. Liquidtight Flexible Metal Conduit (LFMC).

F. Rigid Nonmetallic Conduit (RNC).

G. Thinwall plastic conduit.

H. Conduit fittings.

I. Expansion fittings.

J. Inserts and attachments.

K. Supports, sleeves and seals.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Electrical Components, Devices, and Accessories shall be listed and labeled in accordance with NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Certifications:
1. Conduit: Stamp each length with name or trade mark of manufacturer and affix UL label.

1.4 SUBMITTALS

A. Product Data:
1. Manufacturer's data for each product specified.
2. IBC Certificates of Compliance.

B. Project Information:
1. Provide photos of complete underground conduit installation showing rigid steel bends, required spacers, etc. before backfilling.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As noted for each type listed below.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Rigid Metal Conduit (RMC):
1. Acceptable Manufacturers:
a. Base:
1) Allied Tube and Conduit Corp.
b. Optional:
1) Republic Conduit
2) Wheatland Tube
2. Materials
a. Hot dipped galvanized, or sherardized, including threads.
b. Standard pipe thread with coupling; deliver with thread protector and end caps.
c. Standards:
1) NEMA/ANSI C80.1 – Electrical Rigid Steel Conduit – Zinc Coated (ERSC).
2) UL 6 - Electrical Rigid Metal Conduit – Steel.

B. PVC Coated Steel Conduit:
1. Acceptable Manufacturers:
a. Base:
1) Perma-cote
b. Optional:
1) Plasti-Bond
2) Robroy Industries
2. Materials
a. Rigid steel conduit (RMC): Hot dipped galvanized or sherardized including threads. 40 MIL PVC exterior coating, 2 MIL urethane interior coating.
b. Standard pipe thread with coupling; deliver with thread protector and end caps.
c. Standards:
1) NEMA/ANSI C80.1 – Electrical Rigid Steel Conduit – Zinc Coated (ERSC).
2) UL 6 - Electrical Rigid Metal Conduit – Steel.

C. Rigid Aluminum Conduit (RAC):
1. Acceptable Manufacturers:
a. Base:
1) Allied Tube and Conduit Corp.
b. Optional:
1) RepublicConduit.
2) Wheatland Tube.
2. Materials
a. Rigid aluminum conduit (RAC): AA-6063 aluminum alloy, T-1 temper, Extruded, seamless.
1) Standard pipe thread with coupling; deliver with thread protector.
b. Standards:
1) NEMA/ANSI C80.5 – Electrical Rigid Aluminum Conduit (RAC).
2) UL 6A - Standard for Electrical Rigid Metal Conduit - Aluminum and Stainless Steel.

D. Intermediate Metal Conduit (IMC):
1. Acceptable Manufacturers:
a. Base:
1) Allied Tube and Conduit Corp.
b. Optional:
1) Republic Conduit.
2) Wheatland Tube.

2. Materials:
   a. Intermediate metal conduit (IMC): Hot dipped galvanized steel of intermediate wall thickness including threads.
   b. Standard pipe thread with coupling; deliver with thread protector and end caps.
   c. Standards:
      1) NEMA/ANSI C80.6 –Electrical Intermediate Metal Conduit (EIMC).
      2) UL 1242 - Standard for Electrical Intermediate Metal Conduit – Steel.

E. Electrical Metal Tubing (EMT):
1. Acceptable Manufacturers:
   a. Base:
      1) Allied Tube and Conduit Corp.
   b. Optional:
      1) Republic Conduit.
      2) Wheatland Tube.
2. Materials
   a. Electrical Metal Tubing (EMT): Galvanized steel of thin wall thickness.
   b. Standards:
      1) Nema/ANSI C80.3 –Steel Electrical Metal Tubing (EMT).
      2) UL 797 - Electrical Metallic Tubing – Steel.

F. Flexible Metal Conduit (FMC):
1. Acceptable Manufacturers:
   a. Base:
      1) Anamet Electrical
   b. Optional:
      1) Electri-Flex.
      2) AFC.
      3) International Metal Hose.
2. Materials
   a. Flexible Metal Conduit (FMC): Steel, hot dipped galvanized.
   b. Standards:
      1) UL 1 – Standard for Flexible Metal Conduit.

G. Liquid Tight Flexible Metal Conduit (LFMC):
1. Manufacturers based on specification compliance:
   a. Base:
      1) Anamet Electrical
   b. Optional:
      1) Electri-Flex.
      2) AFC.
      3) International Metal Hose.
2. Materials
   a. Liquidtight Flexible Metal Conduit (LFMC): Steel, hot dipped galvanized with PVC jacket.
   b. Standards:
      1) UL 1660 – Standard for Liquid-Tight Flexible Nonmetallic Conduit.

H. Rigid Non-Metallic Conduit (RNC):
1. Acceptable Manufacturers:
   a. Base:
      1) Carlon.
   b. Optional:
      1) Queen City Plastics.
      2) Cantex

2. Materials:
   a. Rigid Nonmetallic Conduit (RNC): Polyvinyl chloride (PVC), Schedule 40 or 80, meeting minimum requirements of NEC.
   b. Standards:
      1) UL 651 - Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
      2) NEMA TC-2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.

I. Thinwall Non-Metallic Conduit:
   1. Acceptable Manufacturers:
      a. Base:
         1) Carlon.
      b. Optional:
         1) Queen City Plastics
         2) Cantex
   2. Materials:
      a. Thinwall Nonmetallic Conduit: Polyvinyl chloride (PVC), equal to Carlon type EB meeting minimum requirements of NEC.
      b. Standards:
         1) UL 651A - Type EB and A Rigid PVC Conduit.
         2) NEMA TC-6/8 – Electrical Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
   3. Source and Quality Control

J. Conduit Fittings:
   1. Acceptable Manufacturers:
      a. Base:
         1) Appleton Electric.
      b. Optional:
         1) Cooper Crouse-Hinds.
         2) Killark.
         3) Thomas & Betts.
         4) O-Z/Gedney.
   2. Materials
      a. Standards:
         1) ANSI/NEMA FB-1 – Fittings, Cast metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
         2) UL 514B - Conduit, Tubing, and Cable Fittings.
      b. RMC Fittings
         1) Threaded cast ferrous alloy with corrosion resistant finish. Cast body with gasketed corrosion resistant screw cover and threaded hubs.
         2) Not Approved: Zinc alloy and similar soft metal die castings.
      c. IMC Fittings:
         1) Threaded cast ferrous alloy with corrosion resistant finish. Cast body with gasketed screw cover and threaded hubs.
         2) Not Approved: Zinc alloy and similar soft metal die castings.
      d. EMT Fittings:
         1) Steel compression-ring type.
         2) Set screw type fitting with steel body and cup type screws.
         3) Set screw type fitting with pressure-cast bodies for 19mm 3/4 IN conduit and smaller and steel body and cup type screws for 25mm 1 IN conduit and larger.
      e. FMC Fittings:
         1) Dry locations: Squeeze type, malleable iron, cadmium plated, straight and angle connectors for all sizes except twist-in connectors for 19mm 3/4 IN and below flexible metal conduit.
         2) Damp or wet locations: liquid-tight connectors.

f. PVC Conduit Fittings:
   1) PVC plastic solvent weld type, with threaded adapters as required.
g. Bushings:
   1) Threaded, galvanized, malleable iron.
   2) Bushings for conductors No.4 and larger: Separate insulated bushings.
      a) Do not use insulated throat connectors.
   3) Grounding bushings: With screw termination for green grounding wire.
      a) Provide for feeders to panelboards serving critical care areas, per NEC.

K. Expansion Fittings:
1. Acceptable Manufacturers:
   a. Base:
      1) Cooper Crouse – Hinds
   b. Optional:
      1) O-Z/Gedney
      2) Appleton Electric.
2. Materials:
   a. Description:
      1) Watertight deflection type cast slip joint fitting for conduit, with flexible bonding conductor for continuity of ground through metallic conduit.
   b. Design Standards:
      1) O-Z/Gedney: Type DX.
      2) Cooper Crouse – Hinds: Type XJG.

L. Inserts and Attachments:
1. Select inserts and attachments to suit loading conditions.
2. Inserts For Placement in Concrete Formwork:
   a. Malleable iron, wedge with nut, galvanized finish.
   b. Size inserts to suit threaded hanger rods.
3. Attachments to Existing Construction:
   a. Malleable iron, wedge, galvanized finish.
4. Use plastic toggles where securing directly to drywall.
5. Attachments to existing construction are not permitted. See support details.

M. Supports, Sleeves and Seals:
1. Conduit supports:
   a. Standards:
      1) UL 2239 - Hardware for the Support of Conduit, Tubing, and Cable.
      2) Listed and in compliance with other applicable standards.
   b. Designed specifically for electrical installations.
   c. Hangers:
      1) Steel cadmium plated threaded rods with straps or clamp conduit holder.
   d. Straps:
      1) One-hole and two-hole malleable iron, hot-dipped galvanized or steel, cadmium or zinc plated.
   e. Beam Clamps:
      1) Malleable iron, hot-dipped galvanized or cadmium plated.
   f. Channels and Fittings:
      1) Channels: Hot-dipped galvanized.
      2) Fittings: Galvanized.
   g. Trapeze assemblies:
      1) Constructed from channels and supported by at least two (2) threaded rods attached to building structure.
   h. Do not use following to support conduit:
      1) Wire including ceiling support wires.
      2) Perforated strap hangers.

3) Plastic or nylon tie wraps.

2. Sleeves:
   a. Black iron pipe, RMC or IMC sized to accommodate work passing through.
3. Sealer for sleeves and openings around conduit:
   a. UL listed for assembly.
   b. See Section 07 84 00.
4. Sealer for use inside conduits:
   a. Acceptable Manufacturers:
      1) Base:
         a) Arnco.
      2) Optional:
         a) Polywater .
   b. Materials
      1) Description:
         a) Watertight / Air tight foam sealant for electrical conduit.
         b) Listed for application with electrical wiring and conduit.
      2) Design Standards:
         a) Arnco: Hydra-Seal.
         b) Polywater: FST Duct Sealant.

N. Ductbank Accessories:
   1. Acceptable Manufacturers:
      a. Base:
         1) Cantex.
      b. Optional:
         1) Carlon.
         2) GS Industries
         3) Thomas & Betts.
   2. Conduit supports:
      a. Shall be designed specifically for electrical installations.

PART 3 - EXECUTION

3.1 SCHEDULE OF CONDUIT UTLIIZATION

A. Use no conduit smaller than 3/4 IN.

B. Thinwall non-metallic conduit shall only be used for concrete encasement and not be smaller than 50mm 2 IN.

C. Size conduit in accordance with NEC unless indicated larger.

D. Rigid Steel Conduit (RMC) or Intermediate Metal Conduit (IMC) shall be used in following locations unless otherwise noted:
   1. Outdoors Exposed.
   2. In exterior masonry walls.
   3. In wet locations.
   4. For exposed interior runs below 10 FT above finished floor unless otherwise indicated.
   5. For feeders over 600 volts.
   6. In explosion-proof areas.

E. Use PVC coated steel conduit in corrosive areas as noted.

F. EMT shall be used for other 600 volt and below dry applications as follows:
   1. Concealed in walls or above finished ceilings.
   2. Exposed EMT may be used below 3050mm 10 FT level in following locations:
      a. From floor to ceiling in electrical equipment rooms.
      b. Directly above motor control centers in locations other than electrical equipment rooms.

c. Directly above junction boxes or control panels associated with elevators or mechanical equipment with conduit termination point of 6 FT or more above floor.

G. Flexible steel conduit:
1. For connection to equipment subject to vibration.
2. Use liquid-tight flexible conduit for applications, including but not limited to:
   a. All damp and wet locations.
   b. Dietary production and dishwashing areas.
   c. Mechanical pumps.
   d. Laboratory casework.
3. For connection to luminaires above suspended ceilings.
4. In listed office furnishings.
5. In architectural millwork and casework.
6. Where fished into existing walls or ceilings, not otherwise accessible and not subject to physical damage.

H. PVC conduit may be used subject to following:
1. Do not use exposed PVC conduit unless otherwise noted.
2. Provide a 600 volt, insulated, green grounding conductor in each PVC conduit.
   a. Power circuits: Proper ampacity per NEC.
   b. Communications circuits: No.12 AWG minimum.
3. 45 DEG and greater bends in PVC conduit runs shall be made with rigid steel conduit.
4. Schedule 80 PVC conduit may be used for grounding electrode system and telecommunications ground backbone runs below and above grade and stubs through concrete slabs on grade.
5. Direct burial Schedule 40 PVC or concrete encased Type EB may be used as follows:
   a. Underground Ducts and Raceways for Electrical Systems: See Section 26 05 43.
   b. Voice and data systems where underground and in or under concrete slabs on grade.
   c. Underground and concrete encased conduits over 600 volts.

3.2 INSTALLATION

A. Unless otherwise noted install all conduits concealed within walls and above finished ceilings.

B. Do not run horizontally in CMU.

C. Apply Appleton TLC or T and B Kopr-Shield joint compound to conduit threads where installed underground or exposed to weather.

D. Provide separate conduit systems for telephone, exit signs, fire alarm, emergency lighting, and other communications systems, unless otherwise indicated.
1. Separate systems of different voltage classes into different conduit systems unless otherwise noted.
2. Provide dedicated junction boxes and pull boxes to separate wiring systems.
3. Do not combine 208/120 and 480/277V wiring in common wireways or pull boxes.
4. Keep communications systems separated.

E. Where practical, group homeruns to same panelboard.
1. Do not enclose more than three single phase circuits or one three phase circuit in one raceway unless noted otherwise.
2. Exposed overhead conduit may be used in mechanical, electrical and other equipment rooms except conduit drops to following:
3. Where finished walls are provided, conduit drops to wiring devices, fire alarm devices, telecommunications outlets and other flush mounted devices shall be concealed within finished walls.

F. Run non-buried conduit in straight lines at right angles to or parallel with walls, beams or columns.

G. Keep conduit away from uninsulated hot water and steam pipes.
   1. Where crossings are unavoidable, leave minimum 6 IN clearance.

H. Avoid running conduits underneath water lines except for crossings.

I. Do not cross conduit in front of access door in HVAC duct.

J. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

K. Provide conduit support designed for building structural conditions to carry load imposed.

L. Provide inserts or fasteners to attach hangers to structure.
   1. Do not use drilled or explosive driven inserts in precast-prestressed concrete construction.
   2. Drilled or explosive driven inserts may not extend more than 1 IN into post-tensioned concrete construction.
   3. Attachment to metal roof deck may be by means of prepunched tabs, prepunched holes, or with screws in sides of ribs or toggle bolts in bottom of ribs.
   4. Space hangers in joints between precast units minimum 4 IN from walls.

M. Protect inside of conduit from dirt and debris during construction by capping openings with tapered plugs or plastic caps.
   1. If moisture or debris gets into conduit remove before wire is drawn into place.

N. Make conduit field cuts square and ream to full size.
   1. Shoulder conduit in couplings.

O. Use trapeze assemblies to support multiple conduits.
   1. Coordinate layout to provide adequate access to cable tray assemblies if applicable.

P. Installation of conduit or rack of conduits shall not interfere with placement of specified luminaire.

Q. Hangers in roof deck:
   1. Do not extend above tops of ribs, or otherwise interfere with vapor retarder, insulation or roofing.

R. Independently support conduit systems from building structure or walls with approved hangers.
   1. Provide seismic bracing as required. See spec section 26 05 48.
   2. Do not support from piping, ducts or support systems for piping or ducts.
   3. Do not support from ceiling or ceiling support systems.
   4. Do not install to prevent ready removal of equipment, piping, ducts or ceiling tiles.
   5. Do not support from drywall.

S. Do not install conduit under pads for fans, pumps, boilers, or other machinery.

T. Seal and waterproof penetrations of floor slab at mechanical rooms above grade.
   1. Where required, provide firestop systems in accordance with Section 07 84 00.

U. Conduit shall not be installed in structural elements, i.e. concrete columns, beams, decks, or slabs unless otherwise noted.

V. Sum of angles in any conduit run shall not exceed 360 DEG.
   1. Install conduit body, junction box or pull box where additional bends are necessary.
   2. Install pull boxes every 100 FT in long conduit runs.
   3. Conduit body, junction box and pull box covers shall be accessible.
   4. Conduit bodies may be used as follows:
      a. On exposed runs at junctions, bends or offsets where splices are not required.
      b. Around outside corners of walls and equipment or around beams.
   5. Conduit bends:
      a. Make field bends with tools designed for conduit bending.
         1) Heating of metallic conduit to facilitate bending is not permitted.

b. Hand conduit bender may be used on 3/4 IN RMC, IMC or EMT conduit and 1 IN EMT conduit.
   1) Use conduit bending machine for larger sizes.
c. Make no bends with radius less than 12 times diameter of associated cable.
d. No conduit bends shall exceed 90 DEG.

W. Support suspended conduits within 300mm 12 IN of any change of direction of 45 DEG or greater.

X. Make joints in threaded conduit watertight with white nonleaded compound applied to male threads only.
   1. Cut square, ream smooth, and properly thread field joints to receive couplings.
   2. Do not use running threads.

Y. Neatly seal openings around conduits, etc., where they pass through fire rated construction or exterior walls or roof. Provide proper rated seal for fire-rated penetrations.

Z. Conduit passing through concrete wall or slab penetrations:
   1. All core drilling, sleeves, block-outs or other penetrations must be approved by Structural Engineer prior to installation.
   2. Space sleeves and core drills to insure minimum of three (3) times nominal trade diameter of largest adjacent conduit between sleeves or core drills.
   3. Use block-outs for concentrations of conduits in confined area.

AA. No exterior horizontal roof supported conduit runs are permitted in lengths exceeding 6 FT unless indicated otherwise.

BB. Empty conduits:
   1. Install 5mm 3/16 IN minimum diameter polypropylene or nylon pull-line from end to end with tag at each end designating opposite terminus.
   2. Cap conduits indicated to be stubbed out underground with glued-on PVC caps.

CC. Conduit stub-outs:
   1. Extend conduit stub-out to cable tray system and attach to edge of tray with cable tray manufacturer recommended coupling.
   2. Terminate conduit with insulating bushing.

DD. Conduits stubbed into manholes:
   1. Terminate metal conduit with insulating bushing.
   2. Terminate non-metallic conduit with bell ends.

EE. All conduit stub-outs on site shall be identified in one of following ways and noted on as-built drawings provided to Owner:
   1. Permanently marked.
   2. Dimension from landmark on site or building.
   3. Using a Global Positioning System (GPS) device accurate to within 6 IN.

3.3 INSTALLATION - BELOW GRADE NON-CONCRETE ENCASED CONDUIT

A. Maintain depth of conduit at least 762mm 30 IN below finished grade.
   1. Remove materials from trench that could damage conduit.
   2. Use sand or selected material for bedding and first layer of backfill.

B. Use long radius bends and deflection couplings for changes in direction.
   1. Maintain a minimum radius of 914mm 36 IN.

C. Tighten taper-fit joints with light blows of a sledge hammer.
   1. Dope threaded joints and tighten with tool.
   2. Seal plastic joints around entire perimeter with chemical bonding agent.

D. Cap empty conduit.
   1. Seal ends with approved waterproofing compound after conductors have been installed.

E. Provide rigid steel conduit elbows where non-metallic conduit emerges from underground, with threaded adapters for change of material.
   1. Provide 914mm 36IN minimum radius or larger elbows as required by local utility company.

F. Do not place backfill until work is inspected and approved.

3.4 INSTALLATION - CONCRETE ENCASED CONDUIT

A. Conduit design is based upon field assembly of raceways and spacers with concrete cast in place.

B. Unless shown otherwise, use Schedule 40 rigid nonmetallic conduit in concrete encasement.
   1. Keep top of concrete envelope a minimum of 762mm 30 IN below finished grade.
   2. Route conduit lines to clear interferences, but make linear wherever possible.
   3. Use long radius bends and deflection couplings for changes in direction, maintaining a minimum radius of 914mm 36 IN.
   4. Pitch conduit at 76mm 3 IN/100 FT (1:400) away from buildings and toward manholes for drainage.

C. Anchor conduit in place with plastic interlocking spacers 1219mm 48 IN OC to prevent dislocation during concrete placement.
   1. Stagger joints horizontally and vertically.
   2. Tighten taper fit joints with light blows of sledge hammer.
   3. Dope threaded joints and tool tighten.
   4. Seal joints with a chemical bonding agent.

D. Use rigid steel conduit elbows where conduit emerges from underground.
   1. Provide threaded adapters for change of material.
   2. Provide 914mm 36IN minimum radius elbows or as required by local utility company.

E. Provide protection for duct lines in areas of heavy loading such as under footings, foundations, walls, driveways, streets, parking areas and railroads, and in locations where such areas might be extended, such as future roadways.
   1. In addition, provide protection for conduit where soil has inadequate bearing capacity, and in other locations indicated.
   2. Extend protection 1524mm 60 IN on each side of such areas.
   3. For protection of concrete encased conduit, provide reinforcing steel in concrete envelope unless shown otherwise.
   4. Use No. 4 steel reinforcing bars unless indicated otherwise.

F. Provide markers so that underground conduit locations can be visually determined from grade.
   1. Markers: 102mm 4 IN diameter by 610mm 24 IN long non-metallic conduit filled with concrete.
   2. Cast an identifying letter in visible end of each duct, E for electric and T for telephone. Mount top of marker 50mm 2 IN above grade.
   3. Provide markers every 30.48M 100 FT in straight runs; at changes in direction; at building and manhole walls; and on each side of paved areas.
   4. Do not install markers in paved areas.

3.5 INSTALLATION - DUCTLINE IDENTIFICATION

A. Provide identification for conduits not encased in concrete.
   1. Use warning tape for direct buried conduits.
   2. Use concrete colorant for concrete encased conduit.
   3. For warning tape, backfill trench to within 305mm 12 IN of finished grade.
   4. Install tape continuously along entire length of trench, and complete backfill operation.

B. See Section 26 05 53 for concrete colorant and warning tape.

3.6 INSTALLATION - EMPTY CONDUITS

A. Arrange empty conduits for easy installation of future cables.
   1. Cap conduits in accessible locations.

B. Provide a draw line in each empty conduit, tagged at each end with identification and location of other end.
   1. For draw line, use manufactured fish tape, 200 LB test nylon line, or other approved means.

3.7 INSTALLATION - CONNECTIONS AND FITTINGS

A. Install rigid conduits squarely into boxes.
   1. Rigidly clamp to box with locknut on outside and inside and provide bushing on inside.

B. Fit all conduit ends at switch and outlet boxes with approved lock nuts and bushing forming approved tight bond with box when screwed tightly in place.

C. Above lay-in tile ceilings, make connections to lay-in type luminaires with flexible steel conduit no longer than 6 FT.
   1. Arrange conduit and box systems for easy removal of lay-in ceiling.

D. Connect switch legs for narrow switches in hollow metal jamb posts using 1/2 IN flexible steel conduit.

E. Make motor and equipment connections with flexible steel conduit in dry areas and liquid-tight for damp and wet locations, not exceeding 24 IN length.

F. Provide expansion joint fittings as follows:
   1. On conduit at all building expansion or control joints where conduit is rigidly attached to structure.
   2. Where necessary to compensate for thermal expansion and contraction.
   3. Flexible metal conduit may be used for expansion fittings on runs smaller than 1 IN where exposed, or concealed above suspended ceilings.
      a. Leave slack in conduit for movement.
      b. Fasten on each side of joint.

G. Provide junction box with ductseal on raceways subject to different temperatures including but not limited to:
   1. Conduits passing from interior to exterior of structure.
   2. Conduits serving cold storage rooms, freezers and refrigeration equipment.

H. Provide sealing fittings on rigid galvanized conduit in hazardous areas and install in accordance with NEC.

I. When roof exhaust fans are equipped with housing conduit entries and integral disconnects, install conduit to roof exhaust fans through fan housing with no conduit exposed.

END OF SECTION

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SECTION 26 05 34
BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Boxes, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. UL 514A – Metallic Outlet Boxes.
   2. ANSI/NEMA FB-1 – Fittings, Cast metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
   3. ANSI/SCTE 77 Specification for Underground Enclosure Integrity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Dimensioned drawings indicating locations of all floor boxes.

B. Product Data
   1. Describe configurations, finishes, colors, and dimensions for all of following:
      a. Special mounting boxes and covers.
      b. Floor boxes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Galvanized Outlet Boxes and Fittings:
   1. Base:
      a. Emerson Industrial – Appleton Electric
   2. Optional:
      a. Hoffman.
      b. Hubbell Electrical Products - RACO
      c. Thomas & Betts –Steel City

B. Corrosion Resistant and Wet Location Boxes and Fittings:
   1. Base:
      a. Thomas & Betts
   2. Optional:
      a. Robroy

C. Box Supporting Brackets:
   1. Base:
      a. Erico/Caddy
      b. Hubbell/RACO

D. Wet Location Boxes/Covers and Interior Pedestal Boxes:
   1. Base:
      a. Hubbell.

E. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Outlet Boxes:
1. Minimum Size:
   a. 100 MM 4 IN square or octagon.
   b. Depth as required.
2. Lighting outlet boxes:
   a. Galvanized.
   b. Use extension and plaster rings as required.
   c. Verify proper depth with partition thickness.
   d. Provide with proper fittings to support and attach luminaires.
   e. Support outlet boxes for luminaires and other ceiling-mounting devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.
3. Switch and receptacle boxes for concealed wiring:
   a. Galvanized.
4. Exposed switch and receptacle boxes:
   a. Corrosion resistant, cast, malleable iron, with threaded hubs
   b. Design Basis: Crouse-Hinds Type FS.
5. Narrow switch boxes (for hollow metal jambs):
   a. Design Basis: Hubbell-Raco 426.
6. Weatherproof receptacle boxes:
   a. Corrosion resistant cast malleable iron type, with threaded hubs and neoprene gasket.
   b. Design Basis: Crouse-Hinds Type FS.
7. Concealed gang-switch and junction boxes not dimensioned:
   a. Galvanized.
8. Boxes for 277 volt switches on opposite phases:
   a. Where multi-ganging boxes, provide barriers per NEC.
9. Extension Rings:
   a. To suit conditions.
10. Hardware:
    a. Grounding screw and connectors as required by wiring method.
11. PVC coated steel boxes:
    a. Provide NEMA RN-1 compliant coating of PVC.

B. Supports:
1. Box supporting brackets:
   a. Caddy MEB1 and SGB Series.
2. Far side box support:
   a. Hubbell/RACO Catalog No. 978.

C. Pull and Junction Boxes:
1. Minimum Size:
   a. 4 IN square.
   b. Depth as required.
2. Galvanized steel, code gauge.
3. Cover:
   a. Same material as box, screw-on type.

D. Special Receptacle Mounting Boxes/Covers:
1. Weatherproof covers:
   a. Receptacle type as indicated on drawings.
   b. Mount on "FS" cast metal box.
2. Suitable for wet location when receptacle is in use.
   a. Die-cast aluminum construction, meets extra-duty rating in UL 514D.
   b. Padlockable, gasketed NEMA 3R cover.
      1) Single outlets: Hubbell WP700E.

2) Duplex outlets: Hubbell WP8E.
3) Duplex GFCI receptacles: Hubbell WP26E.

3. Recessed Activation Multi-Service Metal Concrete Floor Boxes:
   a. Capable of supplying Power, Data, Voice, and AV services.
   b. Base product: System One by Hubbell Incorporated
   c. Floor box material:
      1) 16 GA galvanized sheet metal.
   d. Gangs, see Drawings:
      1) 2 gang:
         a) Model No. CFB2G30.
         b) 3 IN deep x 6-5/8 IN wide x 13-3/4 IN long.
         c) 70 CU IN capacity.
      2) 4 gang:
         a) Model No. CFB4G30.
         b) 3-1/2 IN deep x 12-1/8 IN wide x 11-1/4 IN long.
         c) 130 CU IN capacity.
   e. Cover:
      1) Provide device plates within boxes as required by application.
      2) Meet requirements of UL514A.
      3) UL scrub water compliant.
      4) Die cast aluminum construction.
      5) 11-11/16 IN long x 7-3/16 IN wide.
      6) Style, see Drawings:
         a) Standard carpet.
            (1) Include two large cable egress doors and 180 degree access opening.
         b) Furniture feed carpet.
            (1) Include 1 IN and 2 IN plugs.
      7) Finish:
         a) Rectangular covers:
            (1) Aluminum powder coated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting Outlet Boxes for Concealed Wiring:
   1. Boxes mounted adjacent to studs shall be attached directly to stud with a minimum of 4 metal screws.
      a. Provide far-side box support on all boxes.
      b. Box side support shall be secured to box with drywall screws.
   2. Boxes that are not attached directly to studs shall be attached to box support bracket spanning studs.
      a. Bracket shall be attached to studs with 2 screws at each end.
      b. Attach box to bracket with 2 screws minimum.
   3. For outlets mounted above or below counters, benches, or furniture, coordinate location and mounting heights with casework, millwork and furniture.
      a. Adjust outlet mounting height to agree with required location for equipment served.
   4. Position outlet boxes to locate luminaires as shown on reflected ceiling plans.

B. When a metallic junction box for electrical receptacles or switches is contained within a 1 or 2-HR rated fire or smoke wall of gypsum wall board construction and an opening is provided for box in surface of wall, area of opening shall not exceed 16 SQIN, unless junction box is protected by approved UL listed firestop.
   1. Aggregate area of such junction boxes in a rated wall not protected by an approved firestop shall not exceed 100 SQIN in 100 SQ FT of wall area as measured from floor to structural deck or rated membrane.

2. Junction boxes with openings on opposite faces of rated walls shall have a horizontal separation of 24 IN as a minimum, regardless of box size, unless protected by an approved method.
3. Locations of studs do not have any bearing on the above requirements, nor does the use of mineral wool fire-safing alter these requirements.

C. Back to back boxes shall not be installed within same stud cavity.
1. Where installation within the same stud cavity is required based on device layout, unfaced glass or mineral fiber sound batting shall be installed to prevent sound transfer between rooms.

D. Fill unused punched-out openings in boxes with closures.

E. Use outlet boxes sized to accommodate quantity of conductors enclosed.

F. Provide pull boxes or junction boxes in conduit runs where indicated or as required to facilitate pulling of wires or making of connections.
1. Make box covers accessible.

G. Paint inside of boxes and box cover per Section 26 00 10.

H. Identify circuit numbers on inside of box and cover plate.
1. Identification shall be post painting of boxes.

I. Coordinate floor boxes with slab depth to assure that concrete depth is adequate for specified box.
1. Set boxes level based on slab depth.
2. Maintain fire rating.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL S YSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Underground Ducts and Raceways for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.

B. Definitions:
   1. Unsuitable material: Debris and/or soil material judged unsuitable by Engineer for support of slabs or other site improvements.
   2. Engineer: Soils Engineer employed by Owner, empowered to conduct inspections and make approvals.
   3. Rock excavation:

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Compaction density test:
   1. Standard Proctor, ASTM D698.

B. Comply with Safety Rules & Regulations for Excavation for local jurisdiction.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Manholes and hand holes.

B. Product Data:
   1. Duct bank conduit separation.

C. Project Information:
   1. Test reports.

1.4 JOB CONDITIONS

A. Protect existing utilities and structures as indicated in Section 26 00 10.

B. Avoid overloading. Keep surcharge sufficient distance back from edge of excavation to prevent slides or caving. Maintain and trim excavated materials in such a manner to be as little inconvenience as possible to public and adjoining property owners.

C. Provide full access to public and private premises, to fire hydrants, sidewalks and other points to prevent serious interruption of travel.

1.5 EXTRA WORK

A. Removal and replacement of unsuitable material below design elevations will be paid for as extra work.
   1. Notify Owner's agent in time to have Engineer measure and record quantity removed.
   2. Recorded quantity will be basis for payment.
   3. Include unit price on Bid Form.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Handholes:

1. Base:
   a. Hubbell Power Systems, Inc.
2. Optional:
   a. Armorcast Products Company.
   b. Synertech.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Duct System:
1. Duct system: Single or multiple, round bore PVC conduits direct buried or completely encased in concrete as indicated.
   a. Rigid PVC conduit: As specified in Section 26 05 33.
   b. Separators: Concrete, plastic or other non-metallic, non-decaying material.
   c. Concrete: 3000 PSI. Conform to Division 03 requirements.
      1) Red coloring shall be added to concrete.
   d. Reinforcing steel: ASTM A615 Grade 60. Conform to Division 03 requirements.
2. Pull wire: Heavy nylon cord, free of kinks and splices.
3. Marker tape: 3 IN wide, .005 IN thick brightly colored plastic tape with continuous metallic backing and a .001 IN corrosion resistant metallic foil core. Tape shall be labeled ELECTRIC, TELEPHONE or SIGNAL at intervals not exceeding 10 FT.

B. Manholes:
1. Electric and telephone manholes: Types as indicated.
   a. Concrete: 4,000 PSI. Conform to Division 03 requirements.
   b. Precast or poured-in-place manholes acceptable.
   c. Cover and frame: 36 IN diameter, gray cast iron, with machine finished seat for perfect joint between cover and frame.
   d. Embossed identification on cover: ELECTRIC, COMMUNICATIONS, or TELEPHONE
   e. Provide floor drain with grate.
   f. Provide cable racks, ladder rungs, 2 ground rods, cable pulling iron.
2. Cable racks: Non-metallic, mounted on wall.
   a. Equip with minimum of 8 adjustable hooks; minimum 2 spare hooks on each rack.
   b. Insulators: Best quality, high-glazed porcelain; provide for each hook.
   c. Space racks so each end of splices are supported horizontally.
3. Ladder rungs: Galvanized, 12 x 12 IN x 3/4 IN diameter.
   a. Set with 7 IN clearance from rung to wall.
4. Ground rods: 3/4 IN x 10 FT long, copper weld.

C. Handholes:
1. Base Product: Quazite by Hubbell Power Systems, Inc.
   a. Construction: Polymer concrete.
   b. Suitable for light vehicular traffic (8000 LB over 10 x 10 IN area).
   c. Designed and tested to temperatures of -50 DEGF.
   d. Meet the requirements ANSI/SCTE 77 Specification for Underground Enclosure Integrity
   e. Secure cover with minimum 2 hex head fastener nuts.
   f. Open bottom.
   g. Embossed identification on cover: ELECTRIC
   h. Dimensions: Nominal 18 IN long x 11 IN wide x 12 IN deep.
   i. Provide 2 IN cover.

D. Backfill material:
1. As approved by Engineer.
2. Free of rock, cobbles, roots, sod, organic matter, and frozen material.
3. Moisture content at time of placement:

a. 3 PCT plus/minus of optimum moisture content.
b. Add water to dry material, or dry wet material as required, or furnish off site material at no additional cost to Owner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove and dispose of materials determined by Engineer to be unsuitable.

B. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

C. Coordinate elevations of duct and duct bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features.
1. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.
2. Lay duct lines to minimum grade of 4 IN in 100 FT.
3. Grade may be from one manhole to next, or both ways from high point between manholes, depending on contour of finished grade.
4. Install duct lines so that top of concrete is not less than 30 IN below finished grade or finished paving at any point.

3.2 INSTALLATION

A. Excavate trenches by open cut method to depth indicated and necessary to accommodate the work.
1. Do not excavate below indicated grades unless required to remove unsuitable material.
2. Backfill over-excavations in firmly compacted 6 IN lifts.
3. Keep trenches free of water.
4. Brace and sheet trenches as soil conditions dictate. Do not remove until backfilling has progressed to a stage that no damage to conduit will result from removal.
5. Permission may be granted for tunnel work for crossing under crosswalks, driveways or existing utility lines.
6. Such tunnels are limited to 10 FT in length.

B. Open no more than 300 LF of trench at one time, or less, as required by Engineer.

C. Clean conduit before using or laying.

D. Lay no conduit in water or in unsuitable weather or trench conditions.

E. Accomplish changes in direction of runs exceeding total of 15 DEG, either vertical or horizontal, by long sweep bends with minimum radius of 25 FT.
1. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.

F. Furnish manufactured bends at end of runs.
1. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for ducts of 3 IN trade size and larger.

G. During construction and after duct line is completed, plug ends of conduits to prevent water washing into conduit or manholes.
1. Keep conduits clear of concrete, dirt, and any other substance during course of construction.

H. Where it is necessary to cut tapered end on a piece of conduit at site, make cut with tool or lathe designed to cut taper to match taper of particular conduit being used.

I. Terminate conduits in end bells where duct lines enter pull boxes or manholes.

J. After duct line has been completed, pull standard flexible mandrel not less than 12 IN long, with diameter approximately 1/4 IN less than inside diameter of conduit, through each conduit. Then pull brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in line.

K. Pneumatic rodding may be used.

L. Install pull wire in unused new ducts.
1. Extend minimum of 3 FT into each manhole or above pads beyond ends of ducts.

M. Encase each conduit in concrete not less that 3 IN beyond any surface of conduit.
1. Stagger conduit joints a minimum of 12 IN in concrete encased duct banks.
2. Mix, place and cure concrete in accordance with Division 03 requirements.

N. Provide uniform spacing between conduits: Not less that 2 IN.
1. Place separators on maximum 4 FT centers.
2. Anchor ducts to prevent movement during placement of concrete.

O. Make conduit joints in accordance with manufacturer's recommendations for conduit and coupling selected.
1. Make conduit joints watertight.
2. Brush plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends.

P. Place marker tape above service lines, electrical feeders and communication ducts outside building footprint. Locate tape 12 IN below finished grade.

3.3 INSTALLATION OF MANHOLES AND HANDHOLES

A. Determine exact location of each manhole and handhole after careful consideration has been given to location of other utilities, grading, and paving.
1. Do not begin construction until location of each manhole and handhole has been approved by Engineer.

B. Construct manholes of type indicated in accordance with applicable details.
1. Mix, place and cure concrete in accordance with Division 03 requirements.

C. Set manhole frames and covers.
1. Paint with 2 coats asphaltic paint after inspection and approval and before setting.
2. In paved areas, set top of manhole covers flush with finished surface of paving.
3. In unpaved areas, set top of manhole covers approximately 1/2 IN above finished grade.
4. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of manhole and manhole frame to temporarily elevate manhole cover to existing grade level.

D. Install cable racks, ladder rungs and cable pulling iron.

E. Drive 2 ground rods into earth not less than 9 FT before manhole floor is placed.
1. Extend ground rods approximately 4 IN above manhole floor.

F. Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days.

3.4 BACKFILLING

A. Perform field tests and verify electrical system complies with specified requirements before backfilling.

B. Hand or pneumatic tamp backfill around and over pipe in lifts not exceeding 8 IN loose thickness.

C. Backfill carefully to avoid displacing pipe joints either horizontally or vertically and to avoid breaking pipe.

D. Do not water flush for consolidation.

3.5 COMPACTION

A. Compact trench backfill in areas under paved roads, parking areas, sidewalks and other structures as directed by Engineer to at least 95 PCT of maximum dry density.

B. In locations where trench will not be under paved areas, compact backfill to minimum 90 PCT of maximum dry density.

C. Remove materials which cannot be compacted as specified.

D. Replace with suitable material and compact.

3.6 FIELD QUALITY CONTROL

A. Perform backfill density tests as directed by Engineer.
   1. Allow for one test per 100 FT of trench.

END OF SECTION

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SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Vibration and Seismic Controls for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SYSTEM DESCRIPTION

A. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment

B. Anchorage of floor and roof mounted electrical equipment.

1.3 QUALITY ASSURANCE

A. Contractor is responsible for design, labor, materials and installation of seismic bracing and anchorage systems.

B. Provide Vibration and Seismic Controls for Electrical Systems engineered to support dead, live, and lateral wind or seismic loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.4 SUBMITTALS

A. Design Drawings:
   1. Layout and mounting detail drawings showing system and proposed brace locations for systems including pre-engineered systems.
   2. Reference specific detail for each type of brace or anchor identifying required locations.
   3. Include plans and details.

B. Product Data:
   1. Technical data on seismic control devices.
   2. Structural calculations for required lateral force level for each component.

C. Project Information:
   1. Engineering calculations indicating design moments, shears, lateral forces and other forces signed and sealed by Specialty Structural Engineer.
   2. Deferred approval items: Provide design and details of anchorages or restraints conforming to Title 24, Section T22-94215 Earthquake Regulations; prepared and signed by a Structural Engineer licensed in State of California.
   3. Certificate that seismic bracing system installed is in accordance with approved shop drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Vibration and Seismic Controls for Electrical Systems:
   1. Base:
      a. International Seismic Application Technology (ISAT).
   2. Optional:

a. Unistrut.
b. Tolco.
c. B-Line.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 DESIGN CRITERIA

A. Provide bracing and anchoring for equipment, conduit, cable tray, bus duct, designed, constructed, and installed to resist stresses produced by lateral forces specified under authority below:
1. California Administrative Code, Title-22 and Title-24.

B. Seismic forces shall be presumed to act through center of mass of equipment in direction that will produce largest single anchor force.

C. See Structural drawings for structural seismic parameters.

2.3 MATERIALS

A. Suspended Bracing Systems:
1. Custom engineered systems designed using specified criteria and common building materials.
2. Provide on-site technical support and installer training by factory trained technical representative or structural engineer providing design.

B. Equipment Anchors and Supports:
1. Drilled-in-place concrete anchors: Approved ICC Evaluation Services Report.
2. Cast-in-place anchors: Comply with ASTM A36, ASTM A307, or ASTM F1554-36.
3. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.
4. Structural steel for supports: ASTM A36
5. Cold formed metal and connection material: Unistrut or equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Design and install bracing and anchoring for equipment, conduit, cable tray, and bus ducts in accordance with requirements of this Section.

B. A run is defined as suspended pipe, conduit, cable tray, bus duct or trapeze rack having minimum 5 FT straight run length.

C. Runs requiring bracing shall have a minimum of two transverse braces and one longitudinal brace.

D. Brace spacing shall not exceed maximum allowable brace spacing as engineered by manufacturer or custom bracing designer.

E. Bracing may be omitted from conduit, cable tray and bus duct runs less than 5 FT in length.

F. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 IN in length are required.
1. Unbraced suspended utility systems having 2 IN conduit and larger or systems weighing more than 5 LB/FT shall be installed with minimum 6IN clearance to suspended ceiling vertical hanger wires.
2. Conduit, cable tray, or bus duct shall be installed such that lateral motion of members will not cause damaging impact with other systems or structural members or loss of vertical support.

G. Longitudinal brace with 90 deg. change in direction may act as Transverse Brace if located within 2 FT of change in direction.

H. Transverse brace may act as longitudinal brace if it is located within 2 FT of change in direction and if brace arm and anchorage have been sized to meet or exceed requirements of Longitudinal Brace.

I. When bracing equipment or utility system suspended from overhead deck, brace back to overhead deck or to structure supporting deck.
   1. Do not brace to another element of structure which may respond differently during seismic event.

J. Obtain approval from Structural Engineer prior to attaching any brace elements to structural steel or wood framing.

K. Tension cable to remove slack from cable bracing without inducing uplift of suspended element.
   1. Tension seismic bracing system prior to equipment start up and adjust after start up.

L. Do not mix rigid bracing with cable bracing in same run unless approved by Structural Engineer.

M. Install brace members at angle of 45 DEG from horizontal within tolerance of plus 2 1/2 DEG or minus 45 DEG provided brace length is accounted for in design. Brace angle may be increased to 60 DEG provided brace spacing is reduced to 1/2 that required for 45 degree brace.

N. Seismic bracing may not pass through building separation joint.
   1. Utility systems that pass through separation joint must be seismically restrained no greater than 5 FT from point of connection.
   2. Install hardware designed to accommodate seismic movement across span of separation joint per manufactures installation and listing instructions.

O. With approval of Structural Engineer, utility systems that are suspended from overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that walls and overhead decks will respond similarly during seismic event.

P. Brace each layer of multiple layer trapeze rack individually based on weight of individual layer.

Q. Conduit, cable tray, or bus duct constructed of non ductile material (plastic, or fiberglass), shall have brace spacing reduced to 1/2 of spacing allowed for ductile materials.

R. Where brace elements are through-bolted, mounting hole in element is to be no more than 1/16 IN in diameter larger than bolt or threaded rod.

S. Seismic braces shall directly brace system and not hanger.

3.2 SUSPENDED ELECTRICAL SYSTEMS

A. Install seismic bracing for conduit 2 1/2 IN trade size or greater.

B. Trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering total weight of elements on trapeze.
   1. For purposes of calculating weight, all conduits are to be treated as full.

C. Brace trapeze racks which support conduit 2 1/2 IN trade size or larger.
   1. Brace other conduit rack, cable tray or bus duct trapezes having minimum weight in excess of 10 LBS, per lineal foot.
   2. Include minimum 10 PCT additional capacity for future additions.

D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 IN or less in length from top of element to bottom of structural attachment of hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.

3.3 FLOOR OR ROOF MOUNTED EQUIPMENT

A. Provide one mounting device on each leg or support with minimum three 3/8 IN diameter anchors.
   1. Do not include friction when designing anchors for shear.

B. Presume seismic forces to act through center of mass of equipment in direction producing largest single anchor force.

C. Presume vertical seismic forces to act concurrently with horizontal seismic forces.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Identification for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.

B. Provide the following:
1. Identification for raceways.
2. Identification for conductors.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 SUBMITTALS

A. Product Data:
1. Manufacturer literature for each electrical identification product indicated.

B. Project Information:
1. Identification Schedule:
a. Index of electrical equipment and system components of identification signs and labels.

1.4 COORDINATION

A. Identification required in this section applies to equipment furnished in other Divisions.

B. Coordinate identification names and abbreviations with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, operation manuals, maintenance manuals, code requirements, standards, and 29 CFR 1910.145.
1. Use consistent designations throughout Project.
2. Equipment identification shall be same as designation indicated on plans.

C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. As scheduled below.

B. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 IN wide; compounded for outdoor use.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Conductor jacketing shall be color-coded as scheduled below.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to permanently identify and locate underground electrical and communications utility lines.
   2. Tape and ink:
      a. Chemically inert.
      b. Unaffected when exposed to acids, alkalis, and other destructive substances found in soil.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes with Black Lettering: ELECTRIC LINE, HIGH VOLTAGE.
   3. Inscriptions for Orange-Colored Tapes with Black Lettering: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Construction:
   1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   2. Thickness: 4 mils .
   3. Weight: 18.5 LB/1000 SQ FT. .
   4. 3 IN Tensile According to ASTM D 882: 30 LBF , and 2500 PSI .

2.4 CONCRETE COLORANT

A. Color Pigment:
   1. Add red color pigment to concrete mixture according to manufacturer's written instructions.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Arc Flash Warning: “WARNING – ARC FLASH HAZARD.”
   2. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting.
   1. Colors as indicated in Identification Schedule below.
   2. Letters:
      a. 1/4 IN high for equipment with cover plate less than 12 IN wide.
      b. 1/2 IN high for equipment with cover plate over 12 IN wide:

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.8 FLOOR MARKING TAPE

A. 2 IN wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 IN below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 IN overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label applied in bands. Install labels at 30 FT maximum intervals.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, manholes, and handholes, use color-coding conductor tape to identify the phase.

C. Boxes: Color code the covers of each junction and pull box.

D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Install underground-line warning tape for both direct-buried conduit as well as conduits in ductbank.

E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

G. Nameplates: Provide engraved laminated nameplates for electrical equipment.
1. Switchgear, switchboard, distribution panel and motor control center nameplates:
   a. Center nameplate near top of first section. Label text to include:
      1) Equipment name and branch, i.e., "Panel XXXX - Life Safety Branch".
      2) Source, i.e., "Source - Switchboard XXXX".
   b. Provide similar nameplates for each main and feeder device. Mount label adjacent to or on cover of device. Label text to include:
      1) Description of load, i.e., "Load - Panelboard XXX".
2. Panelboard nameplates:
   a. Center nameplate near top of each section. Label text to include:
      1) Equipment name and branch, i.e., "Panel XXXX - Life Safety Branch".
      2) Source, i.e., "Source - Switchboard XXXX".
3. Disconnect switches, transformers, contactors, thermal element switches, starters, capacitors, etc. nameplates:
   a. Center nameplate near top of face plate or cover. Label text to include:
      1) Description of load, i.e., "Load - AHU-XXX".
      2) Source, i.e., "Source - MCC-XXXX".
4. Transfer switches:
   a. Center nameplate near top of cover. Label text to include:
      1) Description of load, i.e., "Distribution Board XXXX - Life Safety Branch".
      2) Normal source, i.e., "Normal Source - Switchboard XXXX".
      3) Emergency source, i.e., "Emergency Source - Switchboard XXXX".
5. Fire alarm, public address and other system control cabinet nameplates:
   a. Center nameplate near top of cover. Label text to include:
      1) Description of system, i.e., "Fire Alarm System Control Panel".
6. Relays and relay cabinet nameplates:
   a. Center nameplate near top of cover. Label text to include:
      1) Description of item controlled, applicable system or function and type of device, i.e., "AHU-XXX FA Shut Down Relay" or "Exterior Lighting Circuit XX-X Control Relay".
7. Lighting Control Panel nameplates:
   a. Center nameplate near top of cover. Label text to include:
      1) Equipment name and branch, i.e., "Lighting Control Panel XXXX - Normal Branch".
      2) Control Power Source, i.e., "Control Power – Panel XXXX".

H. Flash Hazard Warning Signs:
1. Provide for all switchboards, panelboards, and motor control centers per NEC Article 110.

I. Device Plates:
1. Color as scheduled in table below and label text as required under Section 26 27 26.

J. Paint outlet boxes, junction boxes and enclosures, except switchboard and panelboard enclosures, as scheduled in table below.

K. Paint emergency system conduits with 2 IN wide band 10 FT on center as scheduled in table below.
1. Pressure-sensitive, color-impregnated tape will be acceptable.

L. High Voltage Signs:
1. Distribution equipment rated over 600 volts and/or pull and junction boxes containing conductors rated over 600 volts shall have a sign posted on the front and rear as applicable:
   a. 1 to 1-1/2 IN high red letters stenciled on a 3 IN high white background.
   b. Sign shall read, "DANGER - HIGH VOLTAGE".

M. Provide color-coding of devices and equipment as indicated below.

Electrical Device and Covers	Normal	Life Safety
Boxes (Outlet, Junction)	Silver (un-tinted)	Yellow
Conduit/Paint/Taping	Silver (un-tinted)	Yellow
Device Plates	White	SS 304
Labeling - Nameplate and Device Plate Background	White	Yellow
Labeling - Nameplate and Device Plate Lettering	Black	Black
LV Ltg Control Switch	White	N/A
Receptacle	White	Yellow
Toggle-type Switch	White	Red
Wall-box Dimmer	White	N/A
Wall-box Occupancy Sensor	White	N/A

Electrical Device and Covers	Generator Upstream of ATS	Fire Alarm	Low Voltage Data	120/208 Volt	277/480 Volt
Boxes (Outlet, Junction)	Black	Red	White	N/A	N/A
Conduit/Paint/Taping	Black	Red	White	N/A	N/A
Labeling - Nameplate and Device Plate Background	Black	Red	N/A	N/A	N/A
Labeling - Nameplate and Device Plate Lettering	White	White	N/A	N/A	N/A
Wire - Ground	N/A	N/A	N/A	Green	Green
Wire - Neutral	N/A	N/A	N/A	White	Gray
Wire - Phase 1	N/A	N/A	N/A	Black	Brown
Wire - Phase 2	N/A	N/A	N/A	Red	Orange
Wire - Phase 3	N/A	N/A	N/A	Blue	Yellow

END OF SECTION

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SECTION 26 09 13
POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Power Monitoring and Control, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 SYSTEM DESCRIPTION

A. Power monitoring system shall consist of electronic circuit monitors, display units and circuit breaker interface modules installed as required or indicated in the project drawings.
   1. The power monitoring system shall have provisions for future connection to a Local Area Network (LAN) and for future remote system monitoring from a personal computer workstation.

B. Power monitoring system shall utilize local system display units to display circuit monitor data.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Outline drawings of assembly.
   2. One line diagrams and wiring diagrams for assembly and components.
   3. Interconnection wiring diagrams.

B. Product Data:
   1. Technical data on each component.

C. Contract Closeout Information:
   1. Operation and Maintenance Data.
   2. Owner instruction reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Power Monitoring and Control:
   1. Base:
      a. Main Service: Siemens #9330DC1000NPZZA
      b. Sub-meters: Class 2000 Three-Phase E-Mon Submeter by Honeywell

B. Other manufacturers desiring approval, comply with Section 01630.

2.2 MATERIALS

A. Main Service: Power Monitoring System Operation:
   1. The power monitoring system shall monitor points in power distribution system and provide local readings as indicated.
   2. The University's existing software shall be used and meter provided shall be compatible with that software. Provide programming, startup and testing of the meter at the building and at the Campus central metering computer. :
      a. Monitoring multiple devices at one time.

3. Installation:
   a. Electronic meters shall be installed by the switchgear manufacturer for all circuits as indicated by the project drawings.
   b. All control power, CT, PT, and communications wiring shall be factory installed and harnessed within the switchgear lineup.
4. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type, to be used.

B. Submeters:
1. Description:
   a. The electronic circuit monitors shall provide metering values such as frequency, temperature, current, voltage, power factor, power, demand current and real power, and accumulated real and reactive energy.
   b. Each circuit monitor shall retain historical circuit data, time and date, setup and configuration values, and diagnostics data in the event of a control power failure, without the need for an internal battery.
2. Installation:
   a. Electronic circuit monitors shall be installed for all panels as indicated by the project drawings.
   b. All control power, CT, PT, and communications wiring shall be installed and harnessed within the power panels.
   c. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type, to be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

B. Power monitoring system components included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

C. Provide wiring required to externally connect equipment lineups.

D. Interconnection wiring requirements shall be clearly identified on the power monitoring system drawings.

E. Provide 1 IN conduit only to meter location from telephone room.

3.2 TESTING

A. Provide programming, startup and testing of the meter at the building and at the Campus central metering computer.

B. Provide a representative of manufacturer to supervise startup and testing of system.

C. Testing to include a complete working demonstration of the power monitoring system with simulation of possible operating conditions which may be encountered.

D. Provide manufacturer's representative for 5 days of start-up assistance.

3.3 OWNER PERSONNEL TRAINING

A. Provide up to 32 HR of on-site training for power monitoring system.

B. Training to include documentation and hands on exercises necessary to enable operations personnel to assume full operating responsibility for the power monitoring system after

completion of training. The University's Facilities Services Administration will be provided with all information they request in order to program the power meter.

END OF SECTION

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SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Lighting Control Devices, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Underwriter's Laboratories (UL):
   1. UL 20 Standard for Safety for General-Use Snap Switches.
   2. UL 514D Cover Plates for Flush-Mounted Wiring Devices.

B. National Electric Manufacturers Association (NEMA):
   1. WD-1 General Color Requirements for Wiring Devices.
   2. WD-6 Wiring Devices - Dimensional Requirements.

C. US Federal Specifications:
   1. Federal Specification switches (WS-896E).
   2. Federal Specification device plates (W-P-455).

D. Local Codes and Standards
   1. California Electrical Code CEC
   2. California Energy Code- Building Energy Efficiency Standards- Title 24
   3. University of Riverside Facility Standards

1.3 SUBMITTALS

A. Product Data:
   1. Technical data on each type of device.
   2. Manufacturer’s wiring and installation information.

B. Contract Closeout Information:
   1. Warranty.

1.4 WARRANTY

A. Minimum five (5) year warranty for occupancy sensors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Standard Toggle Switches:
   1. Base:
      a. Hubbell.
   2. Optional:
      a. Cooper.
      b. Leviton.
      c. Pass & Seymour / Legrand.

B. Line Voltage Occupancy Sensors:
   1. Base:
      a. WattStopper.

2. Optional:
   a. Eaton Greengate.
   b. Hubbell.
   c. Leviton.
   d. Sensor Switch.

C. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Switches:
   1. Toggle switches shall be of the same manufacturer providing receptacles.
      a. See Section 26 27 26.
   2. Lighting switches:
      a. Specification grade, quiet-operating toggle-type with back and side wiring, 120-277 volts, AC only, 20 amp rated unless otherwise indicated.
         1) Switches shall be listed per UL 20 and certified by UL to Federal Specification WS-896E, and shall be visibly marked "Fed Spec WS-896 IN.
         2) All switches shall be equipped with a green grounding terminal.
      3. Use white devices for "normal" circuits.
      4. Refer to symbol legend.
      5. Refer to Section 26 00 10 for device colors.
      6. Toggle-type switch:
         a. Single-pole: Hubbell HBL1221.
         b. Three-way: Hubbell HBL1223.

B. Dimmers:
   1. Wall-box lighting dimmers:
      a. Performance.
         1) Dimmers shall provide full-range, continuously variable control of light intensity of incandescent, electronic low voltage, magnetic low voltage, fluorescent and LED loads.
         2) Slider shall be captured behind an approximately 1 IN wide faceplate opening with a vertical linear-slide. Controls shall be thin profile with no exposed heat sink/yoke.
         3) "Slide-to-OFF" controls shall use the vertical slider to turn the control ON and OFF. "Preset" dimmers shall provide the on/off function independent of the dimmer slider position via a push ON / push OFF switch integral to the slider knob and visibly distinct from the slider. For “Preset” dimmers, when the lights are ON, the slider shall change the light level and when the lights are OFF, the slider shall pre-select the light level to which the lights will turn ON.
         4) Control ON / OFF function must be accomplished utilizing a mechanical air-gap switch to totally disconnect power from the load during OFF condition, and no leakage current shall be present at the fixture(s).
         5) Operation at rated capacity shall be possible across the full ambient temperature range (0 DEGC (32 DEGF) to 40 DEGC (104 DEGF)), without shortening design lifetime. This includes modified capacities for ganging configurations which require the removal of fins.
         6) Dimmer shall provide smooth and continuous Square Law dimming curve, for the full slider travel, on their rated load.
         7) Controls shall meet the applicable requirements of UL 20 and UL 1472 referring to the inclusion of a visible, accessible air-gap off switch and the limited short circuit test.
         8) Controls shall meet ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.

9) Controls shall incorporate power-failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption.
10) Dimmer shall include voltage compensation to compensate light output for variation in the AC line-voltage.
11) 3-way controls shall be connected using conventional 3-way and 4-way wire runs and toggle switches.

2. Wall-box dimmer finishes and face plates.
   a. Dimmers and faceplates shall be white.

C. Occupancy Sensors:
1. Line Voltage Dual Technology Wall Switch Sensor:
   a. Sensor shall be a self contained control system that replaces a standard toggle switch, and shall detect presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes, and shall utilize dual sensing verification for coordination between both technologies to reduce likelihood of false operations.
   b. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout the controlled space.
   c. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens.
   d. Sensor shall have its factory preset in a default mode in which both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain lighting ON, and detection by either technology shall turn lights back ON after lights were turned OFF for 5 seconds or less in automatic mode and 30 seconds or less in manual mode.
   e. Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
   f. Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 DEG.
   g. Sensor shall have no minimum load requirement and shall be capable of switching from 0 to 800 Watt incandescent; 0 to 800 Watt fluorescent or 1/6 hp at 120 VAC, 50/60Hz; and 0 to 1200 Watt fluorescent at 230/277 VAC, 50/60Hz.
   h. Sensor shall be able to control incandescent, magnetic low voltage, electronic low voltage, and fluorescent loads.
   i. Sensor shall feature a walk-through mode, where lights turn OFF 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by a DIP switch.
   j. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.
   k. Sensor shall have a time delay adjustable from 5 to 30 minutes, set by DIP switches.
   l. In automatic mode, sensor shall be capable to automatically return to Automatic-ON after lights are turned off manually.
   m. Sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled.
   n. Sensor shall not protrude more than 3/8 IN from the wall.
   o. Time delay shall be set at 15 minutes and high PIR sensitivity with relay in Automatic ON mode.
2. Dual Technology, Dual Relay Wall Switch Sensor:
   a. Sensor shall be a self contained control system that replaces two standard toggle switches. Sensor shall detect presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes, and shall utilize dual sensing verification for coordination between both to reduce likelihood of false operations.
   b. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout the controlled space.

c. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens.
d. Sensor shall have its factory preset in a default mode in which both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain lighting ON, and detection by either technology shall turn lights back ON after lights were turned OFF for 5 seconds or less in automatic mode and 30 seconds or less in manual mode.
e. Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
f. Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 DEG.
g. Sensor shall have no minimum load requirement and shall be capable of switching from 0 to 800 Watt incandescent; 0 to 800 Watt fluorescent or 1/6 hp at 120 VAC, 50/60Hz; and 0 to 1200 Watt fluorescent at 230/277 VAC, 50/60Hz.
h. Sensor shall be able to control incandescent, magnetic low voltage, electronic low voltage, and fluorescent loads.
i. Sensor shall feature a walk-through mode, where lights turn OFF 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by a DIP switch.
j. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.
k. Sensor shall have a time delay adjustable from 5 to 30 minutes, set by DIP switches.
l. In automatic mode, sensor shall be capable to automatically return to Automatic-ON after lights are turned off manually.
m. Sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled.
n. Sensor shall not protrude more than 3/8 IN from the wall.
o. Time delay shall be set at 15 minutes and high PIR sensitivity with Relay 1 IN Automatic ON and Relay 2 IN Manual ON mode.

3. Dual Technology 360 degree Ceiling Sensor:
a. Sensor shall be capable of detecting presence in control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
b. Ultrasonic sensing shall be volumetric in coverage with frequency of 40 KHz. It shall automatically adjust the detection threshold dynamically to compensate for changing levels of activity and airflow throughout controlled space.
c. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens.
d. Sensor shall coordinate between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting ON.
e. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system ON within 5 seconds of being switched OFF.
f. Sensors shall be ceiling mounted with a flat, unobtrusive appearance and provide 360 DEG coverage.
g. Sensor shall operate at 24 VDC/VAC and utilize a power pack.
h. The lens shall cover up to 1000 SQ FT of walking motion.
i. Sensors shall have a time delay that is adjustable from 5 to 30 minutes, set by DIP switch.
j. Sensors shall feature a walk-through mode, where lights turn OFF 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
k. Sensors shall have a built-in light level sensor that works from 10 to 300 FTcandles.
l. Sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
m. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled.

n. Time delay shall be set at 5 minutes and high PIR sensitivity with relay in Automatic ON mode.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate devices as indicated and as scheduled in Section 26 00 10.

B. Center devices with regard to paneling, furring and trim.

C. Set devices plumb or horizontal and extending to finished surface of wall, ceiling or floor as case may be without projecting beyond same.

D. Route neutral conductor and grounding wire to every junction box containing a line voltage switch.

E. Occupancy Sensors:
1. Verify sensor type, quantity, location, aiming and sensitivity with manufacturer's recommendations.
   a. Set time delays and light level sensitivities of devices, if applicable, per specifications.
   b. For smaller offices, upon entering the room, the photo sensor shall automatically activate between 50-70% of the lights. The occupant shall then be able to manually activate the alternate set of lights, activate 100% of the lights or deactivate all lights. When the room is unoccupied, all of the lights must automatically turn off. When the room is reoccupied, no more than 70% of the lights can be turned back on automatically or from a single switch action. The use of daylighting control must be added for additional control credit.
2. Test controlled spaces to insure 90 to 100 PCT coverage of controlled space.
   a. If test fails, adjust sensitivity, re-aim, relocate, and/or add sensors.
3. Provide training necessary to familiarize Owner’s personnel with operation and proper adjustment of occupancy sensing devices and systems.
4. Locate power supplies and slave units above accessible ceilings.

3.2 CLEANING

A. Remove paint spatters and other spots, dirt and debris from equipment.

B. Clean equipment and devices internally and externally using methods and materials recommended by manufacturer.

C. Correct improperly located devices.

END OF SECTION

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SECTION 26 12 19
PAD-MOUNTED, LIQUID FILLED, MEDIUM VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Pad-Mounted, Liquid Filled, Medium Voltage Transformers, as indicated, in accordance with provisions of Contract Documents.

B. Related Specification Sections include but not limited to:
   1. Section 26 00 10 - Electrical: General Requirements.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. American National Standards Institute (ANSI).

B. Institute of Electronic and Electronics Engineers, Inc. (IEEE):
   1. C62.11 IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>kV)

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
   2. NEMA TR1, Transformers, Regulators and Reactors.

D. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS

A. Shop Drawings:
   1. General arrangement.
   2. Elevations.
   3. Wiring diagrams for accessories.

B. Product Data:
   1. Technical data including assembly and component ratings.
   2. Nameplate drawing.
   3. Mounting and loading information.
   4. Installation instructions and procedures.

C. Project Information:
   1. Certifications.
   2. Factory test reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pad-Mounted, Liquid Filled, Medium Voltage Transformers:
   1. Asea Brown Boveri. (ABB)
   2. Eaton Cooper
   3. General Electric
   4. Siemens
   5. Schneider Electric/Square D

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Transformer:
1. Compartmental type, self-cooled, liquid filled, tamperproof, weatherproof.

B. Dielectric Fluid
1. Envirotemp FR3
2. Rating: 1000 KVA, 3 phase, 60HZ,
3. Temperature rise: 55 degC over a 24 HR 30 degree average ambient.
4. HV rating: 12k V, connected delta with four (4) 2-1/2 PCT full capacity taps in primary winding (2 above and 2 below rated primary voltage).
5. LV rating: 480/277 V, connected wye.
6. HV basic impulse level: 95 KV BIL.
7. Impedance: DOE 2016
8. Core and coil assembly: Wound core type with aluminum windings.
9. Provide tap changing mechanism, externally operable in de-energized condition only.
10. Tank: Sealed, for top oil temperature from 50 DEGC to 106 DEGC, and to withstand 7 PSI pressure without permanent distortion.
    a. Bolted on cover with tamperproof fastenings.
    b. Cooling panels on back and sides, if required.
    c. Lifting eyes and jacking pads.
11. No fastening devices externally removable.
12. Drain valve with sampling device.
13. Dial type thermometer with resettable high temperature indicator.
14. Self-actuating pressure relief device and filing plug.
15. Pressure vacuum gauge
16. Liquid level indicator.
17. Locate HV and LV compartments side by side separated by steel barrier.
18. Doors: With lift off stainless steel hinges.
19. HV and LV compartments: Full height with individual doors.
20. Door stops to hold doors open.
21. Nameplate in low voltage compartment.

C. Compartment:
1. Front sill removable.
2. Tank grounding in accordance with ANSI.

D. High voltage switching and protective equipment:
1. Provide a load break, gang operated, oil immersed switch with "Switch" handle located in the high voltage compartment for operation with distribution hot stick.
    a. Provide 2-position OFF-ON for Radial Feed.
2. Provide drawout, loadbreak, current limiting hookstick-operable fuses.
    a. Interrupting rating: 25,000 A (RMS Sym.).

E. Low voltage switching and protective equipment:
1. Provide a secondary circuit breaker integral to the low voltage compartment of the transformer.

F. Finish:
1. Manufacturer's standard corrosion protection system.
2. Light gray.

G. Sound Levels: Per NEMA TR1.

H. Permanently affix nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

B. Provide concrete pad as detailed.

3.2 ACCEPTANCE TESTING

A. Testing shall be performed in compliance IEEE recommendations and manufacture’s published data.
   1. Insulation resistance
   2. Dielectric absorption
   3. Turns ratio at all tap positions
   4. Sample and test insulation fluid
   5. Insulation power factor test

END OF SECTION

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SECTION 26 13 23
SECTIONALIZING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pad mounted sectionalizing switchgear.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Conditions.
   3. Section 26 00 10 - Electrical - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electronic and Electrical Engineers (IEEE):
      a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
      b. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear (1 kV–38 kV).
      c. C57.12.28, Standard for Pad-Mounted Equipment - Enclosure Integrity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Nameplate data.
      c. See Specification Section 26 00 10 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. General arrangement plan view showing door swings, cable entrance locations, etc.
   4. Test reports:
      a. Certified reports of all factory production tests.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 77 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Record of test results, inspections and procedures witnessed or performed by factory service representative.

1.4 DELIVERY, STORAGE AND HANDLING

A. See Section 26 00 10.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. ABB.
   2. Cooper Power Systems by Eaton.
   3. S&C Electric Company.

B. Submit request for substitution in accordance with Specification Section 01630.

2.2 PAD MOUNTED SECTIONALIZING SWITCHGEAR

A. General:
   1. Deadfront construction.
   2. Configuration: As indicated on the Drawings.

B. Ratings:
   1. Voltage: 15 kV class.
   2. Amperage: 600A.
   3. Number of phases: 3.
   4. Number of wires: 3.
   5. Frequency: 60 Hz.
   6. Short circuit:
      a. Fault closing and momentary: 22.4 kA.
      b. Short time (1 second): 14 kA.
      c. RMS Symmetrical: 14 kA.
   7. Basic impulse level: 95 kV.

C. Construction:
   1. Standards: IEEE C37.20.3 and IEEE C57.12.28.
   2. Enclosure:
      a. Heavy-duty channalized steelconstruction.
      b. Doomed roof.
      c. Full length removable doors with:
         1) Stainless steel hinges and hardware.
         2) Positive 3-point latching system.
         3) Automatically latching door holders.
      d. Lifting provisions.
   3. Full length steel barriers separate side-by-side compartments.
   4. Fiberglass-reinforced polyester barriers (front, interphase and end) for all switches.
   5. Recessed lockable switch handle pocket.
   6. Folding switch handles for all switches, secured inside switch operating pockets.
   7. Shaft lock for each switch so switch can be locked in open or closed positions.
   8. Grounding provisions in each section.
   9. Viewing window for viewing switch position.
   10. Nameplate with circuit diagram, switchgear ratings, manufacturer name and date of manufacture.
   11. Compartmental and phase identification labels.
   12. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
      a. Finish color: Dark green.
   13. Accessories:
      a. Mounting provisions for fault indicator in each switch compartment with viewing window in door.
      b. Key interlock to prevent opening compartment doors unless all switches are locked open.

c. Base spacer to increase cable termination height:
   1) Material: Steel.
   2) Height: 24 IN.

D. Buses:
   1. Material: silver-plated copper.
   2. Bus supports, stand-off insulators and sleeves: Porcelain or epoxy.

E. Load Interrupter Switches:
   1. Three-pole, two-position, gang operated.
   2. Manual quick-make, quick-break utilizing a heavy-duty coil spring to provide openings and closing energy.
   3. Arc extinguishing system.
   4. Insulating barriers between each phase and enclosure.

2.3 SOURCE QUALITY CONTROL

A. Switchgear factory tests in accordance with IEEE and ANSI standards.

2.4 MAINTENANCE MATERIALS

A. Touch-up paint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Arrange as shown on the Drawings.

C. Pad Mounted Sectionalizing Switchgear:
   1. Install on concrete pad per detail on the Drawings.

D. Pedestal Type Sectionalizing Terminal Cabinet: Install on ground sleeve.

E. Miscellaneous: Paint any scratched surfaces with touch-up paint.

3.2 FIELD QUALITY CONTROL

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 2 HRS of on-site training in the operation and maintenance of the unit substation and its components.

END OF SECTION

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SECTION 26 22 13
LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Low Voltage Distribution Transformers, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Provide transformers conforming to following standards:
   1. NEMA ST20 Dry Type Transformers for General Applications
   2. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
   3. ANSI/IEEE C57.12.91 Standard Test Code for Dry-Type Distribution and Power Transformers
   4. DOE 10 CFR Part 431 (DOE 2016) Energy Efficiency Program for Certain Commercial and Industrial Equipment
   5. UL 1561 Standard for Dry-Type General Purpose and Power Transformers

1.3 SUBMITTALS

A. Product Data:
   1. Technical data on each type of transformer.
   2. No load core loss and full load coil loss data.
   3. Percent impedance and X/R ratio data.
   4. Load efficiency curve plots for each type of transformer.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.
      a. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dry-type Transformers:
   1. Base:
      a. Schneider Electric/Square D.
      b. Eaton Electrical.
      c. General Electric.
      d. Siemens.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Insulating materials are to exceed NEMA ST20 standards and be rated for 220 DEGC UL component recognized insulation system.

B. Three phase transformers 15kVA and larger shall be 150 DEGC temperature rise above 40 DEGC ambient.

C. Maximum temperature of top of enclosure shall not exceed 50 DEGC rise above a 40 DEGC ambient.

D. Transformer efficiencies shall be in accordance with DOE 10 CFR Part 431 defined levels effective January 1, 2016. Older in-stock transformers are unacceptable. Efficiency values shall be determined in accordance with DOE 10 CFR Part 431.

Single Phase		Three Phase	
kVA	Efficiency percent	kVA	Efficiency percent
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14

2.3 CONSTRUCTION

A. Transformer coils (except buck/boost type) shall be dual winding of continuous wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish.

B. Cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation point to prevent core overheating.

C. Completed core and coil shall be bolted to base of enclosure but isolated by means of rubber vibration-absorbing mounts.

D. Provide aluminum or copper windings.

E. There shall be no metal-to-metal contact between core and coil and enclosure except for a flexible safety ground strap.

F. Sound isolation systems requiring complete removal of all fastening devices will not be acceptable.

G. Core of transformer shall be visibly grounded to enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

H. Transformer enclosures shall be ventilated (30 kva and above) and fabricated of heavy gauge, sheet steel construction.

I. Provide finish suitable for outdoor applications as applicable.

J. Provide weather shields for outdoor units.

K. Sound levels shall be warranted by manufacturer not to exceed following:
1. 15 to 50KVA: 45dB
2. 51 to 150kVA: 50dB
3. 151 to 300kVA: 55dB.
4. 301 to 500kVA: 60dB.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Provide minimum of 2 IN clearance on both sides and rear of all ventilated transformers or greater when required by manufacturer.

C. External wiring connections: See Section 26 05 33.

D. Provide wall mounting brackets and/or trapeze mounting supports and bracing as indicated or as required.

E. Floor-mounted transformers shall be mounted on concrete pads per Section 26 00 10.

F. Provide labeling per Section 26 05 53.

G. When stacking transformers, provide sheet metal heat shield between transformers.

END OF SECTION

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SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Switchboards, as indicated, in accordance with provisions of Contract Documents.

B. Section Includes:
1. Low voltage switchboards.
2. Completely coordinate with work of other trades.

C. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 00 10 – Electrical General Requirements.
4. Section 26 28 00 - Overcurrent Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American National Standards Institute (ANSI).
   a. ANSI/IEEE C12.16 – Solid State Electricity Metering.
   b. ANSI C39.1 - Electrical Analog Indicating Instruments.
   c. ANSI C57.13 - Instrument Transformers.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. Underwriters Laboratories, Inc. (UL):
   a. UL 489 – Molded Case Circuit Breakers.
   b. UL 891 – Dead-Front Switchboards.
   c. UL 943 - Ground Fault Circuit Interrupters.
   d. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

B. Verify space required for switchgear is equal to or less than space allocated.

C. Secondary unit substation shall be designed, assembled, tested and installed in accordance with latest applicable standards of NEMA, IEEE and ANSI, applicable to its major sections:
1. Medium Voltage Load Interrupter Switchgear – NEMA SG4, SG5; ANSI C37.
2. Secondary Substation Transformers – NEMA 210, IEEE 100, ANSI C57.
3. Low Voltage Metal Enclosed Switchgear – ANSI C37, UL 1558.
4. Low Voltage Switchboards – UL 891.

1.3 SUBMITTALS

A. Submit Switchboard Shop Drawings and Product Data along with, or subsequent to, a complete short circuit analysis and coordination study per Section 26 28 00. Product data or shop drawings submitted prior to power system studies will be rejected.

B. Shop Drawings:
1. Product technical data:
2. Fabrication and/or layout drawings:
   a. General arrangement plan view showing door swings, cable entrance locations, shipping splits, instrument details, etc.
   b. Cross sections, elevations and details.
   c. Mimic bus layout.
   d. Complete single-line and three-line diagrams.

e. AC and/or DC schematics of breaker control, metering, etc.
f. Point-to-point/terminal block wiring diagrams.
g. Cable terminal sizes.
h. Busway connection.
i. Key interlock scheme drawing and sequence of operations.

C. Product Data:
a. Technical data on each component.
b. Nameplate data and legends for equipment.
c. Mounting details and equipment weights.
d. Installation instructions and procedures.
e. See Specification Section 26 00 10 for additional requirements.
f. Component list
g. Conduit space locations within assembly.
h. Assembly ratings including:
1) Short circuit rating.
2) Voltage.
3) Continuous current rating.
i. Major component ratings including:
1) Voltage.
2) Continuous current rating.
3) Interrupting ratings.
2. Overcurrent protective device time-current characteristic curves, specifications and ratings, for coordination with source and load protective devices.

D. Project Information:
1. Certified test reports on protective devices, in enclosures if requested by Architect/Engineer.

E. Contract Closeout Information:
1. Operation and Maintenance Data.
2. Owner instruction report.
3. Installation certification report signed by the manufacturer's representative.
4. Ground fault protection system test reports signed by the projects supervising electrical foreman.
5. Fabrication and/or layout drawings updated with as-built conditions.

1.4 DELIVERY, STORAGE AND HANDLING

A. Remove loose packing and flammable materials from inside switchboard and install temporary electric heating (250W per section) to prevent condensation.

B. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.5 WARRANTY

A. Manufacturer warranty to repair or replace switchgear enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship for three (3) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Switchboards:
1. Base:
a. Eaton Electrical.
2. Optional:
a. General Electric Company.
b. Schneider.

c. Siemens.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 SWITCHBOARDS

A. Ratings:
1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
2. Assembly short circuit current and circuit breaker fault interrupting rating as determined from short circuit study, but not less than 65 kAIC.
3. Bus system with a minimum ANSI 4-cycle short circuit withstand rating of 100 KAIC.
4. Service Entrance Equipment rated when indicated on the Drawings.
5. 100 PCT rated when 100 PCT rated breakers are installed..

B. Construction:
1. Standards: NEMA PB2, UL891.
2. Accessibility: Front.
3. Completely enclosed, dead-front, self-supporting metal structure.
4. Vertical panel sections bolted together.
5. Frames bolted together to support and house bus, cables and other equipment.
6. Frames and insulating blocks to support and house bus, cables and other equipment. Frames and insulating blocks to support and brace main buses for short circuit stresses up to rating indicated on the drawings.
7. NEMA 1 rated enclosure.
8. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
1. Material: Silver-plated copper.
2. Main horizontal bus:
   a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane with provisions for future extension.
   b. Heat rise of all buses shall not exceed ANSI/UL-891 listings.
3. Neutral bus: Fully rated and continuous over length of switchboard with provision for future extension.
4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard, solidly grounded to each vertical section structure and meet the short time withstand rating of the largest breaker.
5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.
6. Main switchboards: Solidly connect main grounding bus to grounding electrode system. Provide ground to neutral bus disconnecting link in service section.
   a. Provide UL “Service Entrance Label”.

D. Vertical Sections:
1. Provide vertical section separation for Emergency main switchboard in compliance with NEC Section 700.

E. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
   a. Drawout insulated case circuit breaker.
2. Feeder overcurrent protective devices:
   a. Individually mounted molded case circuit breaker.
3. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
4. Factory installed.
5. Means to padlock all devices in the open position.

F. Surge Protective Device:
   1. Integrally mounted.

G. Metering:
   1. Power monitor:
      a. Separate compartment with hinged door.
      b. Provide customer metering at each main device. Connect cold sequence.

H. Accessories:
   1. Coordinate installation methods and provide lay down brackets or other hardware to facilitate the installation of the gear without damage
   2. Provide each circuit with engraved nameplate with white cut letters to designate purpose of circuit.

I. Molded Case Circuit Breakers:
   1. Individually mounted devices.
   2. Operation: Manual with manual closing lever.
   3. Construction: Fixed.
   4. Provide integral customer metering at each feeder device. Connect cold sequence.
   5. Provide adjustable ground fault protection for each device.

J. Ground fault indication shall be provided on the main emergency switchboard.

K. Arcflash Measures
   1. Breaker Frames 1200A and greater shall include an Arc Flash Maintenance Switch with Local Annunciations.
   2. Rack out breakers shall be remotely racked in/out.
   3. Breakers shall include a 30 FT long remote breaker operation interface.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Standard factory tests shall be performed on the primary equipment provided under this Section.
   1. Tests shall be in accordance with latest version of ANSI and NEMA standards.

B. Sequence of operation testing shall be completed. The test sequence shall be pre approved by the Owner.

C. Factory tests as outlined above shall be witnessed by the Owner's Representative.
   1. The manufacturer shall notify the Owner Four (4) weeks prior to the date the tests are to be performed.
   2. The manufacturer shall include cost of transportation, meals, and lodging for up to two (2) Owner's Representatives and two (2) Design Engineers.

D. The following standard factory tests shall be performed on the switchgear. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
   1. The switchgear shall completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test in accordance with ANSI C37.20.1.
   2. The wiring and control circuits shall be tested in accordance with ANSI C37.20.1.

3.2 INSTALLATION

A. Install switchgear in accordance with manufacturer's instructions.

B. Arrange switchgear as shown on the Drawings.

C. Indoor Locations:
   1. NEMA 1 enclosure.

2. Install on concrete housekeeping pad.
   a. Align front of switchgear with top edge of pad chamfer and securely bolt to floor sills (C channel) set level (within 1/8 IN) and embedded in the concrete.

D. Install utility provided current transformer and potential transformer in utility metering section of switchboard if required by local utility.

E. Miscellaneous:
   1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
   2. Neatly lace all control wires and have flexibility at hinge locations.

3.3 FIELD QUALITY CONTROL

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Test the ground fault protection and indication systems as indicated in Section 26 28 00.
   1. Ground fault: Test installed ground fault system. Use high current injection method to test system and submit report indicating device settings, tripping time in cycles for each device, test current and date of test as well as name of certified testing firm that performed the test.
      a. Ground fault protection for operation of the main and feeder overcurrent protective devices shall be fully selective such that main device will not open and feeder device will open on ground faults on load side of feeder device. A six cycle minimum separation between main and feeder ground-fault tripping bans shall be provided. Comply with all NEC requirements.

3.4 LABELING

A. Provide switchboard labeling as specified in Section 26 00 10.

3.5 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 2 days of on-site training, for multiple staff shifts, in the operation and maintenance of the switchgear and its' components. Training shall be Video Recorded.

END OF SECTION

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Panelboards, as indicated, in accordance with provisions of Contract Documents.

B. Provide distribution panelboards and lighting and appliance panelboards as specified and indicated on schedules and drawings.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. System Standards:
1. NEMA PB-1 – Panelboards.
2. NEMA PB-1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards rated 600 volt or Less.
3. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
4. UL 50 – Enclosures for Electrical Equipment.
5. UL 67 – Panelboards.
6. CSA Standard C22.2 No. 29-15– Panelboards and Enclosed Panelboards.
7. Federal Specification W-P-115C – Type I Class 1.
8. Federal Specification W-P-115C – Type II Class 1.

1.3 SUBMITTALS

A. Shop Drawings:
1. Identify panelboards by alphanumeric designation with branch circuit breaker sizes and types indicated in panelboard schedules or one-line-diagram.
2. Shop drawings and product data shall be submitted along with, or subsequent to, a complete short circuit analysis and coordination study per Section 26 28 00. Product data or shop drawings submitted prior to power system studies will be rejected.
3. Coordination drawings showing final layout of equipment in all electrical rooms with actual panelboards submitted.

B. Product Data:
1. Technical data on each type of panelboard.

C. Contract Closeout Information:
1. Operating and maintenance data.

1.4 DEFINITIONS

A. Lighting and appliance branch circuit: Branch circuit that has a connection to the neutral of the panelboard and that has overcurrent protection of 30 amperes or less in one or more conductors.

B. Lighting and appliance branch-circuit panel boards: Panelboard having more than 10 PCT of its overcurrent devices protecting lighting and appliance branch circuits.

C. Power Panelboard: Panelboard having 10 PCT or fewer of its overcurrent devices protecting lighting and appliance branch circuits. The terms “power panelboard” and “distribution panelboard” will be used interchangeably.

D. Load Center: Panelboard used in residential or light commercial applications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Panelboards:
   1. Base:
      a. Eaton Electrical.
      b. Schneider Electric/Square D.
      c. Siemens.
      d. General Electric.

B. Other manufacturers desiring approval comply with Section 01630.
   1. Eaton Electrical types listed for quality and performance reference.

2.2 MATERIALS

A. Panelboards:
   1. Dead front type.
   2. Provide with non-insulated equipment grounding terminal strip located in top or bottom gutter including main grounding lug and individual terminals for at least 50 PCT of panel circuits including spare circuits and space provisions; increase gutter space accordingly for grounding strip.
   3. Provide lighting panelboards with branch circuit connection to main bus arranged for sequence phasing.
   4. Provide feed-thru lugs or sub-feed lugs for 2 and 3 section panels.
   5. Equip bus bars for panelboard with main lugs, main fused switch or main circuit breaker, capacity as required or indicated.
   6. Panelboard bussing to be copper.
   7. Provide special features such as split bus, lighting contactors, extra-width gutters as required.
   8. Provide panelboard busses fully rated for specified interrupting rating. Series rating of panelboards and overcurrent protective devices is not acceptable.
   9. Provide full length bussing including areas indicated as space only.
   10. Panelboards served by K-rated transformer shall be provided with neutral bus rated approximately 200 PCT of panel bus rating.

B. Circuit Breaker Panelboards:
   1. Provide bolted-on circuit breaker type. Plug-in circuit breakers not acceptable.
   2. Provide main busses and back panels which permit changing of circuit breakers without additional machining, drilling or tapping.
   3. All multi-pole breakers provide single handle with common trip.
   4. All multi-pole breakers, 100A rated and larger shall include means for padlocking in “OFF” position.
   5. Include provisions for locking specific circuit breakers in the “ON” position where indicated.
   6. Provide shunt trip mechanism on breakers where indicated.
   7. Provide ground fault protection as indicated coordinated with upstream devices.
   8. Design so a combination of one, two and three pole circuit breaker can readily be assembled in the same panelboard.
   9. Circuit breakers operable in horizontal or vertical position and removable from front of panelboard without disturbing adjacent units.
   10. Tandem or half-size circuit breakers not allowed.
   11. Panelboard ratings:
      a. In 120/208 V panelboards: Minimum 10,000 AIC symmetrical, as indicated on drawings, or as required by power systems studies, whichever is greatest.
      b. In 277/480 V panelboards: Minimum 14,000 AIC symmetrical, as indicated on drawings, or as required by power systems studies, whichever is greatest.

12. Lighting and appliance branch-circuit panelboards:
    a. Types PRL1a, PRL2a and PRL3a.
13. Distribution panel boards (circuit breaker type):
    a. Type PRL4B.

C. Cabinets:
1. Galvanized sheet steel, code thickness.
2. 5-3/4 IN deep by 20 IN wide minimum.
3. Provide hinged trim with piano hinge down one side with outer door lock for all flush mounted panels.
4. Multi-section panels shall have equal height enclosures in finished areas.
5. Fasten trim to cabinet by means of adjustable clamps.
6. Equip door with chrome-plated combination lock and catch; supply two milled keys with each lock; key locks alike.
7. Provide directory frame on inside of door.
8. Identify all circuit locations in each respective panel with load and location served.
    a. Directory shall be typed.
    b. Typed directory database (Microsoft Excel file, Microsoft Word file, or equivalent) to be given to Owner to incorporate future circuit changes.
    c. Mechanical equipment identified in directory shall be same as designation indicated on plans.
    d. Room names and numbers in directory shall be final building room names and numbers as identified by Owner and not name or number indicated on plans.
    e. Where circuits in existing panels are modified or added a new updated typed directory shall be provided for the existing panel. Update description for all new, modified and spare circuits and spaces only. All descriptions for existing circuits not affected by Contractor's work will be responsibility of Owner unless otherwise indicated. Submit final draft to Owner for comments or changes prior to typing final directory.

D. Sub-Metering:
1. Standalone or multi-meter unit cabinet.
2. Meters shall be 120/208V or 277/480V, 3-phase, 4-wire configuration.
3. LCD display without multiplier displays accumulative and 'real time' kW load.
4. Demand option displays kW/Demand and kW Peak date and time (15 minute interval standard, 30 minute interval available).
5. 0-2 volt output split-core current sensors promote enhanced safety and accurate remote mounting of current sensors up to 2000 feet from meter without power interruption.
6. Retain meter reading in the event of power failure.
7. Provision for future integration to existing building management system.
8. Certified to California metering standards bureau of weights and measures.
9. Refer to 26 09 13 2.2.B.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Panelboard Cabinet Supports:
1. Finished areas:
    a. Attach to studs via unistrut cross members or metal backing bolted or welded to studs where not otherwise shown.
2. Masonry or concrete walls:
    a. Attach to wall via unistrut cross members where not otherwise shown.

C. Wall mounted panelboards shall be installed 6 IN above floor minimum.

1. Large panels that rest on floor shall be mounted on house-keeping pads per Section 26 00 10.

D. Provide spare conduits into accessible ceiling space from all flush wall mounted panelboards.
   1. Provide one spare 3/4 IN conduit for each 3 spare and/or space branch circuit poles or fraction thereof but no less than two spare 3/4 IN conduits.

E. Electrical Room layout and panelboard installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings indicating final layout of equipment with actual panelboards submitted.

3.2 LABELING

A. Provide panelboard labeling as specified in Section 26 05 53.

B. Permanently post, at each panelboard, the conductor color coding scheme specified in Section 26 05 19.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Wiring Devices, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Provide wiring devices conforming to the following standards:
   1. Underwriter's Laboratories (UL).
      a. UL 498 – Standard for Attachment Plugs and Receptacles.
      b. UL 514D – Cover Plates for Flush-Mounted Wiring Devices.
      c. UL 943 – Standard for Safety for Ground-Fault Circuit-Interrupters.
   2. National Electric Manufacturers Association (NEMA).
      a. WD-1 – General Color Requirements for Wiring Devices.
      b. WD-6 – Wiring Devices – Dimensional Requirements.
   3. US Federal Specifications.
      a. Fed Spec receptacles (WC-596F).
      b. Fed Spec device plates (W-P-455).

1.3 SUBMITTALS

A. Product Data:
   1. Technical data on each type of device.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Wiring Devices:
   1. Base:
      a. Hubbell.
   2. Optional:
      a. Cooper.
      b. Leviton Manufacturing.
      c. Pass & Seymour (Legrand).
   3. All wiring devices shall be provided by the same manufacturer.

B. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Duplex and Single Receptacles:
   1. Flush, grounding convenience outlets for side wiring, or side and back wiring.
   2. Listed per UL 498 for general use and certified by UL to Fed Spec WC-596F, and shall be visibly marked with the "UL-FS" mark to confirm certification.
      a. Constructed with impact resistant nylon or polyester face and body.
      b. 0.050 IN brass nickel-plated back strap with one piece (non-riveted) ground design.
      c. 0.040 IN brass nickel-plated contacts.
   3. Use white devices for "normal" circuits.
   4. Refer to Symbol Legend on Drawings.

5. Receptacles:
   a. Specification grade for general use.
   b. 20A, 125V, 2 pole, 3-wire grounding, duplex, specification grade, NEMA 5-20R; Hubbell HBL5362.
   c. 20A, 125V, 2 pole, 3-wire grounding, single, specification grade, NEMA 5-20R; Hubbell HBL5361.
6. Ground Fault Circuit Interrupter (GFCI) type receptacle:
   a. With built-in ground fault interruption, 4 to 6 mA trip sensitivity, 0.025 second trip time, 10,000 A maximum interrupting capacity, self-testing technology, indicator and reset.
   b. 20A, 125V, 3-wire duplex, specification grade, NEMA 5-20R; Hubbell GFRST20.

B. Special Purpose Receptacles:
1. Straight Blade:
   a. NEMA 6-20R receptacle: 20A, 250V, 2 pole, 3 wire grounding, side and back wired, single; ivory, Hubbell HBL5461I.
   b. NEMA 14-20R receptacle: 20A, 125/250V, 3 pole, 4 wire, 1 phase grounding, single; black; Hubbell HBL8410.
   c. NEMA 15-20R receptacle: 20A, 250V, 3 pole, 4 wire, 3 phase grounding, single, black; Hubbell HBL8420.
   d. NEMA 5-30R receptacle: 30A, 125V, 2 pole, 3 wire grounding, single, black; Hubbell HBL9308.
   e. NEMA 6-30R receptacle: 30A, 250V, 2 pole, 3 wire grounding, single, black; Hubbell HBL9330.
   f. NEMA 10-30R receptacle: 30A, 125/250V, 3 pole, 3 wire, 1 phase, single, brown; Hubbell HBL9350.
   g. NEMA 14-30R receptacle: 30A, 125/250V, 3 pole, 4 wire, 1 phase grounding, single, black; Hubbell HBL9430A.
   h. NEMA 15-30R receptacle: 30A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black; Hubbell HBL8430A.
   i. NEMA 6-50R receptacle: 50A, 250V, 2 pole, 3 wire, 1 phase, grounding, single, black; Hubbell HBL9367.
   j. NEMA 10-50R receptacle: 50A, 125/250V, 3 pole, 3 wire, 1 phase; black; Hubbell HBL7962.
   k. NEMA 14-50R receptacle: 50A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, black; Hubbell HBL9450A.
   l. NEMA 15-50R receptacle: 50A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black, Hubbell HBL8450A.
2. Twist-Lock:
   a. NEMA L5-20R receptacle: 20A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2310.
   b. NEMA L6-20R receptacle: 20A, 250V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2320.
   c. NEMA L14-20R receptacle: 20A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2410.
   d. NEMA L15-20R receptacle: 20A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, twist-lock; black; Hubbell HBL2420.
   e. NEMA L5-30R receptacle: 30A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2610.
   f. NEMA L6-30R receptacle: 30A, 250V, 2 pole, 3 wire, 1 phase grounding, single, twist-lock; black; Hubbell 2620.
   g. NEMA L14-30R receptacle: 30A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2710.
   h. NEMA L21-30R receptacle: 30A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, twist-lock; black; Hubbell HBL2810.

C. Device Plates:
   1. Device plates for concealed wiring: Same manufacturer as devices to suit device covered; single, or ganged, in one piece with beveled edges that match faces of plates.
      a. Flush, brushed-finish, type 304 stainless steel.
   2. Device plates for surface type cast-metal boxes: Corrosion resistant cast ferrous metal designed for application.
   3. Labeling:
      a. General:
         1) Where labeling of device plates is required, provide engraved laminated nameplate or engraved device plate.

D. Plug-In Strip:
   1. Plug-in strip: Surface steel raceway plug-in strip with pre-wired receptacles.
      a. Wiremold AL 4320 or equivalent.
      b. Base, snap-on cover, and fittings as required.
      c. Nominal dimensions 1-3/4 IN wide x 1-3/4 IN deep.
      d. Provide 3 FT, 5 FT or 6 FT lengths as indicated on Drawings.
      e. Gray enamel.
      f. 15A, 125V, 2 pole, 3 wire grounding, single, specification grade, NEMA 5-15R receptacles.
      g. Space receptacles IN O.C.
      h. UL listed under ANSI/UL-5.
      i. Conductors: TW or THHN, 2 No.12 and 1 No.12 TW green for connection to receptacle grounding terminals. Effectively connect green grounding conductor and raceway to building equipment grounding system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate devices as indicated and as scheduled in Section 26 00 10.

B. Center outlets with regard to paneling, furring, trim, tile, etc.

C. Where several outlets occur in a room, symmetrically arrange them.

D. Any outlet which is improperly located must be corrected at Contractor's expense.

E. Set outlets plumb or horizontal and extending to finished surface of wall, ceiling or floor as case may be without projecting beyond same.

F. Install receptacles indicated on wood trim, cases or other fixtures symmetrically. Where necessary, set with long dimension of plate horizontal, or gang in tandem.

G. GFCI Receptacles shall be connected to provide ground fault protection of downstream devices within 6 FT of sinks. All other downstream device shall not be protected by GFCI receptacle.
   1. All protected downstream devices shall be labeled as protected by upstream GFCI receptacle.

END OF SECTION

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SECTION 26 28 00
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Overcurrent Protective Devices, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. System standards:
1. NEMA AB 1 1993 - (National Electrical Manufacturers Association) Molded Case Circuit Breakers and Molded Case Switches
2. UL 489 - (Underwriters Laboratories Inc.) Molded Case Circuit Breakers and Circuit Breaker Enclosures
3. UL 943 - Standard for Ground Fault Circuit Interrupters
4. CSA C22.2 No. 5.1 - M91 - (Canadian Standard Association) Molded Case Circuit Breakers
5. Federal Specification W-C-375B/GEN - Circuit Breakers, Molded Case; Branch Circuit and Service
6. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard.
7. IEEE 141(Red Book) – Recommended Practice for Electric Power Distribution for Industrial Plants.
8. IEEE 399 (Brown Book) – Recommended Practice for Industrial and Commercial Power Systems Analysis.
9. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.
10. NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces.
11. IEEE 519 – Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

1.3 SUBMITTALS

A. Shop Drawings:
1. Power system study:
   a. Submittal 1:
      1) Prior to or at same time as distribution equipment shop drawings and prior to release of equipment for manufacturer. No distribution equipment shall be released for manufacture until Engineer has reviewed and approved power system study submittal 1. Submittal 1 to include preliminary:
         a) Short circuit study.
         b) Coordination study.
         c) Arc flash study.
   b. Submittal 2:
      1) Field verify conductor lengths after installation. Update power system study with actual installed equipment, conductor lengths and any changes in conductor sizes. Submit updated study at least 3 months prior to applying final settings for testing and 6 months prior to substantial completion of project. Include any recommended changes in Submittal 2. Submittal 2 to include final:
         a) Short circuit study.
         b) Coordination study.
         c) Arc flash study.
         d) Harmonics study.

c. Performed by independent, third party firm or by manufacturer of electrical distribution equipment. Study to be stamped and signed by registered professional engineer. Submit credentials of individual(s) performing study and background of firm for approval prior to start of work. Minimum of five years' experience in high and low voltage power system analysis is required for individual in charge of producing study.
d. Provide computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, device numbers and maximum available short-circuit current at each bus.
e. Use specified conductor sizes and estimated conductor lengths for shop drawing.
f. Short circuit study:
   1) Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including utility company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions and recommendations.
   2) Notify Engineer in writing of equipment not properly rated for fault conditions. Identify any prohibited operating/switching scenarios that would over-duty certain identified equipment.
g. Coordination study:
   1) Provide determination of settings, ratings, or types for overcurrent protective devices supplied. Where necessary, appropriate compromise shall be made with system protection and service continuity considered to be of equal importance.
   2) Breakers shall be set to minimize arc flash hazard energy even if overall coordination is compromised.
   3) Provide sufficient number of log-log plots to indicate degree of system protection and coordination. Log-log plots shall include transformer ANSI withstand points and inrush currents of transformers and motors where appropriate.
   4) Computer printouts or equivalent tabular format to accompany log-log plots containing descriptions for all devices indicated on plot, settings of adjustable devices, device numbers to simplify location of devices on system one-line diagram.
   5) Provide data in tabular format of suggested settings of adjustable overcurrent protective devices, equipment where each device is located, device number corresponding to device on system one-line diagram, and number of time-current log-log plots where they are illustrated. Similar or like devices may be illustrated by using "typical" plots. Every device need not be separately illustrated.
   6) Provide discussion section evaluating degree of system protection and system continuity with overcurrent devices, with recommendations as required for increased protection or coordination.
   7) Include complete title and one-line diagram with legend with each curve sheet identifying specific portion of system covered by that particular curve sheet.
   8) Include detailed description of each protective device identifying its type, function, manufacturer and time-current characteristics.
   9) Tabulate recommended device tap, time dial, pickup, instantaneous and time delay settings.
   10) Provide time-current curves graphically indicating coordination proposed for system, centered on 8.5 x 11 IN, log-log forms.
   11) Any inadequacies shall be called to attention of Engineer and recommendations shall be made for improvements.
h. Arc flash study:
   1) Provide arc flash study in conjunction with short circuit and protective device coordination study.
   2) Include all electrical distribution equipment in study including but not limited to:
      a) Switchgear and switchboards.
      b) Distribution and branch circuit panel boards.
      c) Motor control centers.

d) Individual circuit breakers, disconnect switches and molded case switches,
e) Utilization equipment with integral disconnects or panels such as variable frequency drives, packaged mechanical equipment and UPS.
f) Automatic transfer switches.

3) Arc flash boundary distances and incident energy at each device shall be determined by worst case incident energy at that device resulting from maximum and minimum available fault current at main distribution switchgear or switchboard for each valid system operating/switching mode under all probable source conditions. For low voltage equipment (600 volt and below), incident energy calculations shall be made at 100 PCT and 85 PCT arcing current per IEEE 1584.
4) Provide tabulation of data for each bus analyzed.

B. Product Data:
1. Technical data on each type of device including:
a. Outline drawings with dimensions.
b. Ratings for voltage, amperage and maximum interrupting ratings.
c. Trip unit functions and adjustments
d. Accessories.
e. Wiring diagrams.
f. Manufacturer shall provide hard copy time/current characteristic trip curves (and Ip & I^2t let through curves for current limiting circuit breakers) for each type of circuit breaker.
2. Submit with associated switchgear, switchboard, panelboard or other assembly.

C. Contract Closeout Information:
1. Operation and Maintenance Data.
a. Include instructions for circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.
2. Final power system study based on actual installed equipment, field measured conductor lengths and any applicable modifications to contract documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Overcurrent Protective Devices.
1. Base:
a. Eaton Electric.
b. Schneider Electric/Square D.
c. Siemens.
d. General Electric.

B. Fuses:
1. Base:
a. Bussmann.
b. Ferraz Shawmut.
c. Brush.
d. Littelfuse.

C. Equipment and devices by same manufacturer.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Circuit Breakers:
1. Provide circuit breakers as required by other specifications and drawings. Provide special features as indicated including but not limited to:
   a. Ground fault protection.
2. Provide lugs rated for 75 degree C wire minimum.
3. Contractor shall review one line diagrams and confirm that circuit breakers have adequate lugs to accommodate size and quantity of conductors indicated on one line diagrams, panel and motor control schedules.
4. Lugs shall be UL Listed to accept solid (not larger than #8 AWG) and/or stranded copper and aluminum conductors.
5. Circuit breakers shall be capable of accepting bus connections.
6. Overcurrent devices shall be fully rated for available fault current unless otherwise specifically indicated.
7. Frame sizes 1000 and greater shall include ground fault protection.
8. Frame sizes 1200 and greater shall include "Arc Flash Maintenance Mode" switch and local annunciator.
9. Molded case type:
   a. Constructed of glass reinforced insulating material. Current carrying components shall be completely isolated from handle and accessory mounting area.
   b. Provide over center, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. Provide common tripping of two and three pole circuit breakers.
   c. Circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing International I/O markings.
   d. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
   e. Provide each circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit breaker tripping mechanism for maintenance and testing purposes.
   f. Provide factory seal with date code on face of circuit breaker.
   g. Provide circuit breakers equipped with UL Listed electrical accessories as noted on associated schedule or drawing.
   h. Provide circuit breaker handle accessories with provisions for locking handle in ON and OFF position as noted on associated schedule or drawing.
   i. Provide circuit breakers UL Listed for reverse connection without restrictive line and load markings and suitable for mounting in any position.
   j. Provide circuit breakers UL Listed to accept field installable/removable mechanical type or compression type lugs. Provide lug body bolted in place; snap in design not acceptable.
   k. Thermal-Magnetic Circuit Breakers:
      1) Used only as follows unless otherwise indicated:
         a) Main, feeder and branch circuit breakers in lighting and appliance panelboards as defined in Section 26 24 16.
         b) Main, feeder and branch circuit breakers rated 125 amps and less in distribution panel boards as defined in Section 26 24 16.
         c) Motor circuit protectors.
      2) Do not use in switchboards rated over 400 amps.
      3) Provide permanent trip unit containing individual thermal and magnetic trip elements in each pole.

4) Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true rms sensing and thermally responsive to protect circuit conductor(s) in a 40 DEGC ambient temperature.
5) Provide circuit breaker frame sizes above 150 amperes with magnetic trip adjustment located on front of circuit breaker.
6) Provide UL Listed HACR type for two- and three-pole circuit breakers rated up to 250 amperes at 600 VAC.
7) Provide Class A (5 ma) sensitivity breaker where GFCI circuit breakers are indicated.
8) Provide equipment ground fault protection where indicated with following provisions:
   a) Modified zero sequence sensing system.
   b) Ground fault sensing system:
      (1) Requiring no external power to trip circuit breaker.
      (2) Suitable for use on grounded systems and suitable for use on three-phase, three-wire circuits where system neutral is grounded but not carried through system or on three-phase, four-wire systems.
      (3) Include ground fault memory circuit to sum time increments of intermittent arcing ground faults above pickup point.
      (4) Shall not affect interrupting rating of companion circuit breaker.
   c) Companion circuit breaker equipped with ground-fault shunt trip and capable of group mounting.
   d) Field adjustable Ground fault pickup current setting and time delay with switch for setting ground fault pickup point and means to seal pickup and delay adjustments.
   e) Means of testing ground fault system to meet on-site testing requirements of NEC.
   f) Local visual ground fault trip indication.

l. Electronic trip circuit breakers with standard function trip system
   1) Provide standard function trip system on circuit breakers rated less than 400 amps unless otherwise indicated.
   2) Provide circuit breaker trip system with microprocessor-based true rms sensing design with sensing accuracy through thirteenth (13th) harmonic and sensor ampere ratings as indicated on associated schedules or drawings.
   3) Provide integral trip system independent of any external power source and with industrial grade electronic components.
   4) Determine ampere rating of circuit breaker by combination of interchangeable rating plug, sensor size and long-time pickup adjustment on circuit breaker. Clearly mark sensor size, rating plug and adjustment positions on face of circuit breaker.
   5) Provide circuit breakers UL listed to carry 100 PCT of ampere rating continuously for circuit breakers with frame sizes 250 amp or greater.
   6) Provide following time/current response adjustments, each with discrete settings independent from other adjustments:
      a) Instantaneous Pickup.
      b) Long time pickup and delay.
      c) Short time pickup.
      d) Short time delay (I^2t IN only).
      e) Ground fault pickup and delay (I^2t OUT only) where indicated.
   7) Provide means to seal trip unit adjustments in accordance with NEC..
   8) Provide local visual trip indication for overload, short circuit and ground fault trip occurrences as applicable.
   9) Provide Long Time Pickup indication to signal when loading approaches or exceeds adjusted ampere rating of circuit breaker.

10) Provide trip system with Long Time memory circuit to sum time increments of intermittent overcurrent conditions above pickup point and means to reset Long Time memory circuit during primary injection testing.
11) Provide circuit breakers equipped with thermal protection in trip unit to protect breaker from catastrophic failure and instantaneous magnetic override set at the withstand rating of the circuit breaker.
12) Provide trip system equipped with externally accessible test port for use with Universal Test Set. Disassembly of circuit breaker shall not be required for testing. Provide test set capable of verifying operation of trip functions with or without tripping circuit breaker.

m. Electronic trip circuit breakers with full function trip system:
1) Provide full function trip system on circuit breakers rated 400 amps and greater.
2) Provide circuit breaker trip system with microprocessor-based true rms sensing design with sensing accuracy through thirteenth (13th) harmonic and sensor ampere ratings as indicated on associated schedules or drawings.
3) Provide integral trip system independent of any external power source and with industrial grade electronic components.
4) Determine ampere rating of circuit breaker by combination of interchangeable rating plug, sensor size and long-time pickup adjustment on circuit breaker. Clearly mark sensor size, rating plug and adjustment positions on face of circuit breaker.
5) Provide circuit breakers UL listed to carry 100 PCT of ampere rating continuously for circuit breakers with frame sizes greater than 250 amps.
6) Provide following time/current response adjustments, each with discrete settings independent from other adjustments:
a) Instantaneous pickup.
b) Long time pickup and delay.
c) Short time pickup.
d) Short time delay (I^2t IN and I^2t OUT).
e) Ground fault pickup and delay (I^2t IN and I^2t OUT) where indicated.
f) Ground fault alarm only where required by NEC.
7) Provide means to seal rating plug and trip unit adjustments in accordance with NEC.
8) Provide Long Time Pickup indication to signal when loading approaches or exceeds adjusted ampere rating of circuit breaker.
9) Provide trip system with Long Time memory circuit to sum time increments of intermittent overcurrent conditions above pickup point and means to reset Long Time memory circuit during primary injection testing.
10) Provide circuit breakers equipped with thermal protection in trip unit to protect breaker from catastrophic failure and instantaneous magnetic override set at the withstand rating of the circuit breaker.
11) Provide trip system equipped with externally accessible test port for use with Universal Test Set. Disassembly of circuit breaker shall not be required for testing. Provide test set capable of verifying operation of trip functions with or without tripping circuit breaker.

n. Equipment Ground Fault Protection (Electronic Trip Circuit Breakers):
1) Provide circuit breakers with integral equipment ground fault protection where indicated for grounded systems. Provide circuit breaker suitable for use on three-phase, three-wire circuits where system neutral is grounded but not carried through system or on three-phase, four-wire systems.
2) Provide separate neutral current transformer for three-phase four-wire systems as indicated on schedules or drawings.
3) Provide ground fault sensing system with residual sensing, source ground return or modified differential type.

4) Provide trip system with ground fault memory circuit to sum time increments of intermittent ground faults above pickup point.
5) Provide means of testing ground fault system to meet on-site testing requirements of NEC.
6) Provide local visual trip indication for ground fault trip occurrence(s).

10. Electronic trip power circuit breakers with full feature trip system and following provisions:
    a. Constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard.
    b. Draw-out mounting.
    c. Manually operated or electrically operated as indicated.
    d. Suitable for required instantaneous rating without use of current limiting fuses.
        1) Field interchangeable electrical accessories including shunt trip, spring release, electrical operator, auxiliary contacts and Trip Unit.
    e. Secondary connections made directly to front of circuit breaker cradle.
    f. Built-in contact temperature and contact wear sensors.
    g. Padlocking provisions to receive up to three padlocks when circuit breaker is in disconnected position, positively preventing unauthorized closing of circuit breaker contacts.
    h. Up to two key locks allowing locking in disconnected position.
    i. Capability for locking in connected, test and disconnected positions by padlock or key lock.
    j. Buttons on face of circuit breaker, with lockable clear cover, to open and close circuit breaker and indicators to show:
        1) Position of circuit breaker contacts.
        2) Status of closing springs
        3) Circuit breaker position in cell.
    k. Indicator to show “charged–not OK to close” if closing springs are charged but circuit breaker is not ready to close.
    l. Circuit breaker racking system with positive stops at connected, test, disconnected and withdrawn positions.
    m. Circuit breaker equipped with interlock to discharge stored energy spring before circuit breaker can be withdrawn from its cell.
        1) Positive ground contact check between circuit breaker and cell when accessory cover is removed while circuit breaker is in connected, test or disconnected positions.
    n. Trip Units:
        1) Removable to allow for field upgrades.
        2) Incorporate “True RMS Sensing” and LED long-time pickup indications.
        3) Provide following time/current response adjustments, each with discrete settings independent from other adjustments.
            a) Instantaneous pick-up including “OFF” setting.
            b) Long-time pickup and delay (adjustable and field-replaceable).
            c) Short-time pickup.
            d) Short-time delay (I^2t IN and I^2t OUT).
            e) Ground fault pickup and delay (I^2t IN and I^2t OUT) where indicated.
            f) Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of residual, source ground return, and modified differential ground fault protection. Ground-fault sensing systems shall be field-modifiable. Provide where indicated.

B. Fuses:
1. UL Class L fuses: Dual-element time-delay and current-limiting type fuses; UL Class L listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 600V, 601-6000A, Type KRP-C.
   a. Use for main and main feeder devices over 600A, where fuses are indicated.
2. UL Class RK-1 dual-element fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-1 listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 0-600A, 250V Type LPN-RK and 600V Type LPS-RK.
   a. Use for main feeder devices 600A and smaller where fuses are indicated.
3. UL Class RK-1 single-element fuses: Fast-acting current-limiting rejection type fuses; UL Class RK-1 listed for 200,000 rms AIC symmetrical; Bussmann "Limitron" 1/10-600A, 250V Type KTN-RK and 600V Type KTS-RK.
   a. Use as indicated.
4. UL Class RK-5 fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-5 listed for 200,000 rms AIC; Bussmann "Fusetron" 1/10-600A, 250V Type FRN-RK and 600V FRS-RK.
   a. Use for motor feeder and branch circuit devices where fuses are indicated.
5. Elevator fuses: Type and rating as required by elevator manufacturer. Confirm requirements with elevator manufacturer prior to ordering fuses.

C. Fusible Switches:
1. Provide panelboard type suitable for mounting in switchboards or panelboards as indicated.
   a. 200,000 AIC, 30 thru 1200 A, with fuses specified above.
   b. Provide ground fault protection system with current sensor, shunt trip and control power transformer where indicated.
2. Provide bolted pressure contact switches suitable for mounting in switchboards as indicated.
   a. 200,000 AIC, 800 thru 4000 A, with fuses specified above.
   b. Electrically operated as indicated.
   c. Provide ground fault protection with current sensor, shunt trip and control power transformer where indicated.

2.3 POWER SYSTEM STUDY

A. Use SKM-PTW to provide computer generated power system study of specified electrical power distribution system in accordance with IEEE 141 and 399.
1. Include electrical distribution system from main distribution equipment (including utility and generator sources) down to each 208 volt branch circuit panelboard. Study shall include each valid system operating/switching mode under all probable source conditions.
2. Data collection:
   a. Provide required data for preparation of studies. Performer of studies shall furnish contractor with listing of required data immediately after award of contract.
   b. Expedite collection of data to assure completion of studies as required for final approval of equipment shop drawings.
   c. Input data shall include power company's short circuit contribution as calculated and verified by them.
   d. Verify characteristics of utility service overcurrent devices with power company.

B. Analysis shall include:
1. Short circuit study:
   a. Scenarios that result in maximum fault conditions shall be adequately covered in study. For example, if closed transition transfer switches are provided or if utility is paralleled with standby generators at any time, combined contribution from utility and generators shall be considered.
   b. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors and/or generators.

c. Calculate 1/2 cycle (or 5 cycle where appropriate for MV equipment) short circuit interrupting and momentary (asymmetrical 'close and latch') duties, when applicable for an assumed 3-phase bolted fault at each load interrupter switchgear, transformer primary and secondary terminals, low-voltage switchgear, switchboard, distribution panelboards, bus duct, automatic transfer switch, motor control center, 480 volt panelboard, 208 volt panelboard and other significant locations throughout system.
d. Include equipment/device ratings, X to R ratios and symmetrical fault currents in tabulations. Where actual (calculated) X/R ratio exceeds device test X/R ratio, appropriate fault duty adjustment shall be made in accordance with ANSI/IEEE standards and included in tabulations.
e. Base transformer impedance on lowest tolerance limit allowed by ANSI C57.12 (7.5 PCT below listed value). Use actual nameplate impedance when available.
f. Include fault contribution of motors.

2. Coordination study:
   a. All potential scenarios shall be considered in study. Scenarios to be considered include but are not limited to:
      1) For basic system with single service, study shall show coordination between main, feeders and downstream devices.
      2) If main switchgear or switchboard is double-ended with main-tie-main arrangement, study shall show coordination between main, tie, feeders and downstream devices when tie breaker is closed. Where overlap cannot be avoided, tie breaker shall be set to overlap downstream feeder overcurrent devices rather than main devices.
      3) If multiple levels of ground fault are provided time current curves shall be provided that indicate coordination of ground fault between main, tie and feeder breakers when tie breaker is closed. Where overlap cannot be avoided, tie breaker shall be set to overlap downstream feeder overcurrent devices rather than main devices.
      4) Provide graph to indicate coordination between typical 20 amp, 277 volt, single pole breaker and nearest upstream 480 volt overcurrent device with ground fault protection as applicable.
      5) Evaluate proper operation of ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided. Discuss neutral grounds and ground fault current flows during a neutral to ground fault.
      6) Include phase and ground coordination of generator protective devices. Indicate generator decrement curve and damage curve along with operating characteristic of protective devices. Obtain information from generator manufacturer and include generator actual impedance value, time constants and current boost data in study. Do not use typical values for generator.
      7) For motor control circuits, indicate distribution equipment full-load current plus symmetrical and asymmetrical of largest motor starting current and time to ensure protective devices will not trip during major or group start operation.
      8) All emergency system overcurrent protective devices shall fully coordinate per applicable requirements of NEC. Where this is not possible due to pre-determined device types, sizing or trip unit selections, notify Engineer immediately of inadequacies and include recommendations for resolution.
   b. Graphs shall include as applicable:
      1) Utility relay and fuse characteristics.
      2) Campus substation relay and fuse characteristics.
      3) Medium-voltage equipment relay and fuse characteristics.
      4) Low-voltage equipment circuit breaker trip device characteristics.
      5) Pertinent transformer characteristics.
      6) Pertinent motor and generator characteristics.
      7) Characteristics of other system load protective devices.
      8) All devices down to and including largest branch circuit overcurrent protective device in each motor control center, distribution panel and branch panelboard.

9) All adjustable settings for ground fault protective devices.
10) Manufacturing tolerance and damage bands in plotted fuse characteristics.

c. Indicate transformer full load and 150, 400 or 600 PCT currents, transformer magnetizing inrush, ANSI transformer withstand parameters and significant symmetrical and asymmetrical fault currents.

d. Select each primary protective device required for delta-wye connected transformer so that its characteristic or operating band is within transformer characteristics including point equal to 58 PCT of ANSI withstand point to provide secondary line-to-ground fault protection. Where primary device characteristic is not within transformer characteristics, indicate transformer damage curve.

e. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device could be exposed.

3. Arc flash study:
   a. Perform arc flash analysis in accordance with NFPA 70E with calculations performed in accordance with IEEE 1584A.
   b. Provide following data for each bus analyzed.
      1) Flash Bus Name.
      2) Protective Device Name.
      3) Bus Operating Fault Current.
      4) Protective Device Bolted Fault Current.
      5) Protective Device Arcing Fault Current.
      6) Trip/Delay Time (SEC).
      7) Breaker Opening Time (SEC).
      8) Ground.
      9) Equipment Type.
      10) Gap (mm).
      11) ARC Flash Boundary (IN).
      12) Working Distance (IN) consistent with Owner's arc flash policy.
      13) Working Distance (IN) per IEEE Table 3 default values.
      14) Incident Energy (CAL/cm^2)
      15) Required Protective FR Clothing (PPE) Category.
   c. Provide following data on each arc flash hazard warning label:
      1) Flash Hazard Protection Boundary.
      2) Incident Energy Level.
      3) Required Personal Protective Equipment Category with brief description.
      4) Shock hazard when cover is removed.
      5) Limited Approach Boundary.
      6) Restricted Approach Boundary.
      7) Prohibited Approach Boundary.
      8) Include date of calculation, utility short circuit capacity and voltage as of that date.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide overcurrent protective devices in switchboards, panelboards and motor control centers as indicated in those sections.

B. Provide individually enclosed overcurrent protective devices:
   1. Wall mounted:
      a. Finished areas: Attach to studs via unistrut cross members or metal backing bolted or welded to studs where not otherwise shown.
      b. Masonry or concrete walls: Attach to wall via unistrut cross members where not otherwise shown.
      c. Mounting height shall be as indicated on symbol legend or elsewhere in this specification but bottom of enclosure shall not be less than 12 IN AFF.

2. Where floor mounted provide pad per Section 26 00 10.

C. Field Settings:
1. Perform field adjustments of protective devices as required to place equipment in final operating condition. Settings shall be in accordance with approved power system study.
2. Provide certified calibration report for each protective device.

D. Arc Flash Labels:
1. Provide Arc flash hazard warning label on each piece of electrical equipment.

E. Arc Flash Boundaries:
1. Identify arc flash protection boundaries in front of all electrical switchboards, switchgear, panel boards, motor control centers, UPS distribution panels, automatic transfer switches and individual disconnects and circuit breakers. Provide outline of arc flash protection boundaries with 2 IN wide strip of red/white Seton M6356 OSHA warning tape or equivalent.

END OF SECTION

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SECTION 26 28 16
ENCLOSED SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Enclosed Safety Switches, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Provide fuses in fusible-type devices by same manufacturer.

1.3 SUBMITTALS

A. Product Data:
   1. Technical data on each type of disconnect switch.

B. Contract Closeout Information:
   1. Operation and Maintenance Data.
      a. See Section 01 77 00.

1.4 EXTRA MATERIAL

A. Extra Fuses:
   1. 10 PCT or minimum of three (3) of each type and rating of installed fuses.
   2. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Enclosed Safety Switches:
   1. Eaton
   2. Schneider Electric/Square D
   3. Siemens
   4. General Electric

B. Elevator Control Switch:
   1. Eaton
   2. Bussman

C. Other manufacturers desiring approval comply with Section 01630.

2.2 SAFETY SWITCHES

A. Safety Switches:
   1. Fusible and non-fusible type, NEMA Type HD Heavy Duty construction, unless otherwise indicated.
   2. Enclosure: NEMA 1 unless otherwise indicated.
   3. Provide weatherproof disconnect switches as required by Section 26 00 10.
   4. Switch blades fully visible in OFF position with door open.
   5. Contact operation quick-make and quick-break.
   6. Switches for motor circuits to be horsepower rated.
   7. Switches for motor circuits controlled by Variable Frequency Drives (VFD) shall include one N.O. and one N.C. contact which operate with the initial movements of the switch and prior to the opening of the main switch.

8. Provide padlocking provisions, with a minimum capacity of 2 padlocks, in OFF position.
9. Finish: Baked enamel over rust-inhibiting primer.
10. Fuses for fusible switches: See Section 26 28 00.
11. Switches shall have interlock with cover in closed position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Switches for motor circuits controlled by VFD's shall be electrically interlocked to the controlling VFD via contacts provided in switch.

C. Provide labeling per Section 26 00 10.

END OF SECTION

SECTION 26 43 13
SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Surge Suppression Devices, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 DESCRIPTION

A. This specification includes surge protective devices that clamps transient voltage, diverts surge current and attenuates high-frequency electrical line noise.

B. Surge protective devices shall be located at service entrance equipment and at downstream switchgear, switchboards, motor control centers, busway, distribution panelboards and/or branch circuit panelboards where indicated on Drawings or Panelboard Schedules.

C. Surge protective devices shall be internally mounted within the protected equipment enclosure.

D. Surge protective devices shall be externally mounted in its own separate enclosure adjacent to the enclosure of the protected equipment.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Engaged in design and manufacturer of specified system for a minimum of five (5) years
   2. SPD manufacturer shall be same as manufacturer of protected equipment.

B. Design, manufacture, test, and install SPD equipment in compliance with latest edition of following standards:
   1. American National Standards Institute and Institute of Electrical and Electronic Engineers:
      a. ANSI/IEEE-C62.41.1 Guide on the Surge Environment in Low Voltage AC Power Circuits.
      b. ANSI/IEEE-C62.41.2 Recommended Practice on Characterization of Surges in Low Voltage AC Power Circuits.
      c. ANSI/IEEE-C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.
   2. American National Standards Institute and Underwriters Laboratories:
      a. ANSI/UL-50 Enclosures for Electrical Equipment.
      b. ANSI/UL-67 Panelboards.
      c. ANSI/UL-845 Motor Control Centers.
      d. ANSI/UL-857 Busway.
      e. ANSI/UL-891 Dead Front Switchboards.
      f. ANSI/UL-1283 Electromagnetic Interference Filters.
      g. ANSI/UL 1449 Third Edition, Surge Protective Devices.
      h. ANSI/UL 1558 Metal Enclosed Low Voltage Power Circuit Breaker Switchgear.
   3. National Fire Protection Association:
      a. NFPA-70 National Electrical Code.
      b. NFPA-780 Lightning Protection Systems.
   4. Military Standards
      a. MIL STD 220C Method of Insertion Loss Measurement.
   5. Underwriters Laboratories:
      a. UL 96A Lightning Protection Systems.

C. Internally mounted SPD equipment shall be UL-1449 and UL-1283 Listed or shall be UL-1449 and UL-1283 component recognized as a surge protective device and electromagnetic interference filter. The protected equipment including the SPD shall be fully tested and certified to the applicable switchgear, switchboard, motor control center, busway and/or panelboard UL Standard.

D. Externally mounted SPD equipment shall be UL-1449 and UL-1283 listed as a surge protective device and electromagnetic interference filter.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Submit unit dimensions, weights, mounting provisions, connection details and layout diagrams of each SPD application.
   2. Indicate location with respect to protected bus and connection characteristics to bus including material type, length and routing.

B. Product Data:
   1. Copy of UL 1449 Certification under Category VZCA or VZCA2 with applicable model numbers highlighted and indicating following information:
      a. Model number.
      b. Product Type.
      c. Voltage.
      d. Phase.
      e. Voltage protection rating per mode.
      f. Nominal discharge current rating per mode.
      g. Maximum continuous operating voltage rating per mode.
   2. Standard catalog data sheets indicating:
      a. Modes of protection.
      b. Surge current capacity per mode.
      c. Surge current capacity per phase.
      d. Short circuit current rating.
      e. Filter attenuation.
      f. Diagnostics and monitoring features.

C. Contract Closeout Information:
   1. Operation and Maintenance Data.
      a. See Section 01 77 00.
   2. Warranty.

1.5 STORAGE AND HANDLING

A. SPD equipment shall be shipped, stored and handled in accordance with manufacturer's instruction.

1.6 WARRANTY

A. Manufacturer's Limited Ten-Year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Surge Suppression Devices:
   1. Base:
      a. Eaton/Cutler-Hammer – SPD Series.
      b. Square D/Surgelogic – IMA/EMA Series

c. Siemens Energy & Automation/Sentron – TPS3 Series.
d. General Electric – TR7000 Series.
2. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Environmental Requirements:
1. Operating temperature range shall be minus 40 DEGC to plus 50 DEGC.
2. Relative humidity range shall be 5 PCT to 95 PCT non-condensing.
3. Capable of operation at altitudes up to 16,000 FT above sea level.
4. No audible noise.
5. No appreciable emissions of EMI/RFI fields.

B. General Electrical Requirements:
1. SPD shall be a combination of a solid state, parallel connected surge suppression device and an electromagnetic interference filter.
2. The surge suppression elements shall be Metal Oxide Varistor (MOV).
3. Each MOV shall be provided with individual over-current and thermal over-temperature protection.
4. Surge current shall be equally distributed to all components to ensure equal stressing and maximum performance.
5. Nominal operating voltage: as indicated on the drawings or panelboard schedules.
6. Nominal operating frequency: 60 Hz.
7. Protection modes: provide directly connected suppression elements between line and neutral (L-N), line and ground (L-G), and neutral and ground (N-G).
8. Maximum Continuous Over Voltage (MCOV) shall equal or exceed the following:
a. 208Y/120 volt systems:
1) L-N: 150.
2) L-G: 150.
3) N-G: 150.
4) L-L: 300.
b. 480Y/277 volt systems:
1) L-N: 320.
2) L-G: 320.
3) N-G: 320.
4) L-L: 640.
9. Voltage Protection Rating (VPR) shall not exceed the following:
a. 208Y/120 volt systems:
1) L-N: 800.
2) L-G: 800.
3) N-G: 800.
4) L-L: 1200.
b. 480Y/277 volt systems:
1) L-N: 1200.
2) L-G: 1200.
3) N-G: 1200.
4) L-L: 2000.
10. Nominal discharge current rating: 20kA.
11. Short circuit current rating (SCCR): 200kA.
12. EMI/RFI filter shall provide minimum 50 dB noise attenuation at 100 kHz using MIL-STD-220A insertion loss test method.
13. Diagnostics and monitoring:
a. Solid state monitoring of each mode and power loss in any phase.
b. Externally visible green/red LED operational status indicator lights for each protection mode. Absence of a green light and presence of red light shall indicate which mode(s) or phase(s) have been damaged.

c. Audible alarm with silence switch shall sound if any fault condition occurs.
d. Form C dry contacts (1 NO/1 NC) for remote status monitoring. Contacts shall change state if any fault condition occurs.
e. Test switch shall test SPD's diagnostics and monitoring system.
f. Surge counter with LCD display shall indicate the quantity of transients recorded. Count shall be stored in non-volatile memory. Provide reset pushbutton with two second duration to reset.

C. Specific Electrical Requirements by Application/Location:
1. Internally mounted within service entrance equipment:
a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
b. Tested and suitable for use in ANSI/IEEE C62.41 Category C environments.
c. Surge current capacity:
1) Maximum surge current rating per phase shall be minimum 250kA.
2) Maximum surge current rating per mode shall be minimum 125kA.
d. Factory installed.
1) SPD equipment shall be located within the service entrance equipment enclosure and installed in the factory by the service entrance equipment manufacturer.
2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the service disconnect. If direct bus connection is not possible, conductor leads may be provided. Conductor leads shall be kept as short and straight as possible. Leads shall be minimum #8 conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4 IN 100 MM spacing.
3) Provide a remote diagnostics panel mounted on the cover of the service entrance equipment enclosure and visible from outside the enclosure.
2. Internally mounted within distribution equipment and/or panelboards serving rooftop equipment:
a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
b. Tested and suitable for use in ANSI/IEEE C62.41 Category C or B environments.
c. Surge current capacity:
1) Maximum surge current rating per phase shall be minimum 160kA.
2) Maximum surge current rating per mode shall be minimum 80kA.
d. Factory installed.
1) SPD equipment shall be located within the distribution equipment enclosure and installed in the factory of the distribution equipment manufacturer.
2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the main circuit breaker if provided. Neutral and ground leads shall be kept as short and straight as possible. Leads shall be minimum #8 conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4 IN 100 MM spacing.
3) Provide a window in the equipment to allow the diagnostics panels to be visible from outside the enclosure. If not, provide a remote diagnostics panel mounted on the cover of the distribution equipment enclosure and visible from outside the enclosure.
e. SPD mounting shall not limit the use of through-feed lugs, sub-feed lugs or sub-feed breakers.
f. Panelboards shall be capable of being placed back in re-energized service upon removal of the SPD.
3. Internally mounted within branch circuit panelboards:
a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
b. Tested and suitable for use in ANSI/IEEE C62.41 Category B environments.
c. Surge current capacity:
1) Maximum surge current rating per phase shall be minimum 100kA.

2) Maximum surge current rating per mode shall be minimum 50kA.

d. Factory installed.
   1) SPD equipment shall be located within the panelboard enclosure and installed in the factory of the panelboard manufacturer.
   2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the main circuit breaker if provided. Neutral and ground leads shall be kept as short and straight as possible. Leads shall be minimum #8 conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4 IN 100 MM spacing.
   3) Provide a window in the panelboard cover to allow the diagnostics panels to be visible from outside the enclosure.

e. SPD mounting shall not limit the use of through-feed lugs, sub-feed lugs or sub-feed breakers.

f. Panelboards shall be capable of being placed back in re-energized service upon removal of the SPD.

D. Factory-test SPD equipment prior to shipment, including but not be limited to:
   1. Quality assurance checks.
   2. MCOV and let-through voltage verification tests.
      a. MCOV testing shall consist of units burned-in at applicable MCOV for a minimum of one (1) hour.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD equipment per manufacturer's recommendations.

B. Externally mounted SPD equipment:
   1. Mount as close as practical to the protected bus. For panelboard applications, wall mount the SPD immediately adjacent to the circuit breaker serving it.
   2. Conductors shall be as short and straight as possible between SPD and circuit breaker.
   3. Conductor size shall be minimum #8 IN minimum 1 IN conduit. Provide larger conductors and conduit as recommended by the manufacturer.
   4. Provide a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4 IN spacing.
   5. Seal conduit after placement of conductors.

C. Do not energize SPD's until distribution system has been energized, stabilized and tested.

D. Disconnect SPD's during distribution system insulation resistance testing.

END OF SECTION

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SECTION 26 51 13
BUILDING LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Building Lighting, as indicated, in accordance with provisions of Contract Documents.

B. Section includes interior luminaires and accessories, lamps, ballasts and drivers.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Where groups of luminaire types on Lighting Equipment Schedule exhibit same manufacturers, final installation shall consist of same manufacturer's equipment across groupings as specified for consistency of optics, color of light, finishes, aesthetics and similarity of maintenance procedures.
   1. Mixing/matching across groups is unacceptable except where specified.
   2. Mixing/matching across multi-phased projects is unacceptable, except where products have subsequently been discontinued or significantly redesigned in size, appearance, lamping or gear.
   3. See Lighting Equipment Schedule for additional information.

B. Coordinate ballasts/drivers used with lamping/LED modules, lamp sockets, and control devices prior to submitting shop drawings.

C. Provide luminaires bearing UL labels, and tested by a nationally recognized testing facility under UL1598 and UL 8750, and manufactured in accordance with NEC.

D. Lamps and ballasts shall comply with U.S. Federal Efficiency laws and TCLP compliance Standards.

E. Materials and installations shall be in accordance with latest revision of National Electrical Code and any applicable Federal, State and local codes and regulations.

F. Luminaires shall comply with relevant and current ANSI, CBM, ESTA, FCC, IEC, IEEE, IESNA, NEMA, NFPA, and UL standards and practices.

G. American National Standards Institute (ANSI):
   1. ANSI C62.41.2 IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000 V and less) AC Power Circuits
   2. ANSI C78.376: Chromaticity of Fluorescent Lamps (ANSI/NEMA C78/376-96).
   3. ANSI C78.377: Specifications for the Chromaticity of Solid State Lighting Products.
   4. ANSI C81.64: Electric Lamp Bases and Holders.
   5. ANSI C82.1: American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts
   6. ANSI C82.2: Fluorescent Lamp Ballasts, Methods of Measurement of (includes supplements)
   7. ANSI C82.4: American National Standard for Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
   8. ANSI C82.11: American National Standard for Lamp Ballasts--High-Frequency Fluorescent Lamp Ballasts
   9. ANSI C82.77: Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment.

10. ANSI E1.3: Entertainment Technology Lighting Control System 0 to 10V Analog Control Specification.
11. ANSI E1.20: Remote Device Management over DMX512 Networks.
12. ANSI/IES RP-16-10: Nomenclature and Definitions for Illuminating Engineering.

H. Certified Ballast Manufacturers Association (CBM):
1. Requirements for Ballast Certification.

I. Federal Communications Commission (FCC):
1. Code of Federal Regulations (CFR), Title 47, Part 18, Industrial, Scientific, and Medical Equipment
2. Code of Federal Regulations (CFR), Title 47, Part 15 Class B: Radio Frequency Devices, Commercial Rated.

J. International Electrotechnical Commission (IEC):
1. IEC 61000-3-2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
2. IEC 61347-1: General and Safety Requirements for Lamp Control Gear
3. IEC 61347-2-13: Particular Requirements for DC or AC. Supplied Electronic Controlgear for LED Modules
4. IEC 61547: Equipment for general lighting purposes - EMC Immunity Requirements.
5. IEC 62384: DC or AC Supplied Electronic Control Gear for LED Modules - Performance Requirements.
6. IEC 62386-101: Digital Addressable Lighting Interface - Part 101: General Requirements - System.
7. IEC 62386-102: Digital Addressable Lighting Interface - Part 102: General Requirements - Control Gear.
8. IEC 62386-207: Digital Addressable Lighting Interface - Part 207: Particular Requirements for Control Gear - LED Modules (Device Type 6).

K. Institute of Electrical and Electronic Engineers (IEEE):
1. IEEE C62.41-91: Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits.

L. Illuminating Engineering Society of North America (IESNA):
1. IES LM-9: Electrical and Photometric Measurements of Fluorescent Lamps
2. IES LM-15: IESNA Guide for Reporting General Lighting Equipment Engineering Data for Indoor Luminaires
3. IES LM-20: Approved Method for Photometry of Reflector-Type Lamps
4. IES LM-28: IES Guide for the Selection, Care and Use of Electrical Instruments in the Photometric Laboratory
5. IES LM-40: Approved Method for Life Performance Testing of Fluorescent Lamps
6. IES LM-41: Approved Method: Photometric Testing of Indoor Fluorescent Luminaires
7. IES LM-45: Electrical and Photometric Measurements of General Service Incandescent Filament Lamps
8. IES LM-46: Photometric Testing of Indoor Luminaires Using High Intensity Discharge or Incandescent Filament Lamps
9. IES LM-47: Approved Method for Life Testing of High Intensity Discharge (HID) Lamps
10. IES LM-49: Life Testing of Filament lamps
11. IES LM-50: Method for Photometric Measurement of Roadway and Street Lighting Installations
12. IES LM-51: Electrical and Photometric Measurement of High Intensity Discharge Lamps.
13. IES LM-52: Photometric Measurements of Roadway Sign Installations
14. IES LM-54: Guide to Lamp Seasoning
15. IES LM-61: Identifying Operating Factors Influencing Measured Vs. Predicted Performance for Installed Outdoor High Intensity Discharge (HID) Luminaires

16. IES LM-62: Laboratory or Field Thermal Measurements of Fluorescent Lamps and Ballasts in Luminaires
17. IES LM-63: ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information
18. IES LM-64: Photometric Measurements of Parking Areas
19. IES LM-65: Life Testing of Single-Based Fluorescent Lamps
20. IES LM-66: Electrical and Photometric Measurements of Single-Based Fluorescent Lamps
21. IES LM-72: Directional Positioning of Photometric Data
22. IES LM-76: Photometric Testing of Fiber Optic Lighting Systems
23. IES LM-79: Electrical and Photometric Measurements of Solid-State Lighting Products
24. IES LM-80: Measuring Lumen Maintenance of LED Light Sources
25. IES LM-82: Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature
26. IES LM-84: Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines and Luminaires
27. IES LM-85: Electrical and Photometric Measurements of High-Powered LEDs
28. IES TM-21: Projecting Long Term Lumen Maintenance of LED Light Sources
29. IES TM-30: IES Method for Evaluating Light Source Color Rendition

M. National Electrical Manufacturer's Association (NEMA):
1. NEMA LE1: Fluorescent Luminaires.
2. NEMA LE2: HID Lighting System Noise Criterion (LS-NC) Ratings.
3. NEMA FAl: Outdoor Flood Lighting Equipment.
4. NEMA LSD 23: Recommended Practice - Lamp Seasoning for Fluorescent Dimming Systems.
5. NEMA LL9: Dimming of T8 Fluorescent Lighting Systems.
6. NEMA SSL1: Electronic Drivers for LED Devices, Arrays, or Systems.
7. NEMA SSL3: High-Power White LED Binning for General Illumination.
8. NEMA SSL7A: Phase Cut Dimming for Solid State Lighting: Basic Compatibility.
9. NEMA 410: Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts

N. National Fire Protection Association (NFPA):
1. NFPA 70: National Electrical Code (NEC)
2. NFPA 101: Life Safety Code

O. UL International (UL):
1. UL 1310 Standard for Class 2 Power Units
2. UL 8750 Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.3 SUBMITTALS

A. Shop Drawings:
1. For continuous pattern luminaires, indicate layout, individual section lengths, and lamp/LED module quantities.
   a. Show details of connections, emergency ballast/driver and lamp/module placement, corners and extensions, end plates, and mounting. Include pendant or bracket locations and show remote transformers/ballasts/drivers.
   b. Provide field-measured overall dimensions in wall-to-wall and wall-to-corner applications.
2. Details of special construction, accessories, and finishes.

B. Product Data:
1. Submit product data for fixtures indicated on Electrical Drawings, Specifications and Schedules.
2. Identify luminaires by Lighting Equipment Schedule designation.
   a. For each luminaire, provide cutsheets indicating following information:
      1) Name of manufacturer, cutsheet, and complete catalog number.

a) Include product data details for catalog number references to explain special construction, accessory or finish, and photometric data.

2) Photometric Data:
   a) Collected by an independent testing laboratory.
   b) Indicate optical performance developed using methods of Illuminating Engineering Society of North America (IESNA) as follows:
      (1) Coefficients of utilization.
      (2) Candlepower data presented graphically and numerically, in maximum 10 degree increments.
      (3) Develop data for up and down quadrants that are normal, parallel, and at 45 DEG to lamp if light output is asymmetric.
      (4) Zonal lumens stated numerically in 10 degree increments as above.
      (5) Fixture efficiency.

3. Solid state Luminaires:
   a. LED Luminaires:
      1) Total input wattage.
      2) Luminaire voltage.
      3) Delivered lumens.
      4) Color temperature, color rendering index (CRI), and individual R-values, measured in accordance with IESNA standards.
      5) Rated life, measured in accordance with IESNA standards.
      6) Total harmonic distortion (THD).
      7) Submit in tabular format the characteristics of submitted fixture per the technical information categories of the Lighting Equipment Schedule. Deviations from specified criteria shall be identified by a +/- percentage.
      8) Submit the rated lumen maintenance life of LED luminaires. Life shall be reported based upon the light source's L70 rating.
   b. LED Drivers:
      1) Driver manufacturer and model number.
      2) Driver rated life.
      3) Driver dimensions.
      4) Driver type (0-10V, constant voltage, constant current).
      5) If applicable, include lumen management protocols.
      6) Dimming range and control device compatibility list.
      7) Wiring Diagrams – as needed for special operation or interaction with other systems.
4. Coordinate ballasts/drivers used with lamping/LED modules, lamp sockets, and control devices prior to submitting Shop Drawings.
5. Upon request, provide calculations performed in AGi32 IN specific spaces as identified by Architect for submitted optional manufacturers or substitutions.
6. Coordinate luminaires with ceiling construction.
   a. Confirm clearances and fixture flange compatibility with construction.

C. Project Information:
   1. Manufacturer's installation instructions.

D. Contract Closeout Information:
   1. Manufacturer's Warranty shall be from date of Substantial Completion.
      a. Include labor allowance for full cost of component replacement.
      b. Provide warranties, as specified, for the following equipment:
         1) Finish.
         2) Lenses.
         3) Housings.
         4) Ballasts.
         5) Lamps.
         6) Transformers.

7) LED Drivers.
8) LED Luminaires.

2. Warrant electronic fluorescent ballasts for five years from Date of Substantial Completion. Include labor allowance for full cost of ballast installation.
3. Warrant LED drivers for five years from Date of Substantial Completion.
   a. Include labor allowance for full cost of driver installation.
4. Warrant the luminaire and all of its components (except the ballast/transformer/driver) to be free from defect in operation or finish for five years from the date of Date of Substantial Completion.
   a. Warrant LED modules during this period for color and lumen maintenance (percent shift +/- degrees Kelvin).
   b. As long as luminaire has been operated within the rated voltage range, Contractor is responsible for cost of materials and labor necessary to repair or replace luminaire.
5. It is the responsibility of the Contractor to manage all warranty issues that may arise.
6. Inventory of lamp/ballast and driver/module replacement stocks.
7. At time of Substantial Completion as defined by the Architect, submit all installation and maintenance tools received from various luminaire vendors clearly and permanently tagged with Manufacturer's name and relevant luminaire type(s) to the Owner's Representative.
8. Maintenance and Operating Manuals.
   a. See Section 01 77 00.

E. Review of shop drawings and product data does not waive the Contractor of their obligations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Luminaires:
   1. Base:
      a. As indicated on Lighting Equipment Schedule.
   2. Optional:
      a. As indicated on Lighting Equipment Schedule.
   3. Use catalog numbers listed as a guide only. Follow modifications and other requirements shown or specified.

B. Lamps/LED Modules:
   1. GE Lighting.
   2. Osram Sylvania.
   3. Philips Lighting.
   4. Cree (LED only).
   5. Soraa (LED only)
   6. Xicato (LED only).

C. Drivers:
   1. Osram Sylvania.
   2. Philips Advance.
   3. Mean Well.
   4. eldoLED.
   5. Hatch.
   6. Lutron.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS

A. Luminaires:
1. Resistant to corrosion and thermal and mechanical stresses encountered in normal application. Provide accessory equipment such as starters, sockets and lampholders, approved by UL and ETL, unless otherwise noted.
2. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.
3. Housings:
   a. Troffer luminaires: Minimum 22 GA 0.76 MM sheet steel; integral end plates and trim flanges to suit ceiling construction. Provide wire way covers with captive retainers to allow access to electrical components without use of tools.
   b. Downlight luminaires: Minimum 22 GA 0.76 MM sheet steel, or minimum 0.0508 IN sheet aluminum, unless noted otherwise. Provide auxiliary junction box secured to mounting frame.
   c. Extruded aluminum housings, where scheduled, shall be at least 1/8 IN thick.
   d. Punch and form housings prior to finishing (post-paint).
   e. Ballast/driver surface shall be in complete contact with housing, having the mounting method designed for efficient conduction of ballast heat.
4. Trim:
   a. For square and rectangular luminaires, miter and continuously weld corners. Miter perimeter inverted T-Bar angles at corners. Do not butt or overlap squared ends. Finish joints smooth.
5. Castings:
   a. Uniform quality, free from imperfections affecting strength and appearance. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.
6. Fasteners:
   a. For aluminum or steel luminaires, fastening hardware shall be cadmium-plated or an equivalent. For stainless steel luminaires stainless steel fasteners shall be used. For bronze luminaires, the fastening hardware shall be bronze or stainless steel.
7. Finishes: As selected from manufacturer's standards unless scheduled otherwise.
   a. Painted surfaces, except as scheduled otherwise:
      1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish; acrylic, alkyd, epoxy, polyester or polyurethane.
      2) White finishes shall have minimum 85 PCT reflectance.
   b. Unpainted aluminum surfaces:
      1) Interior luminaires: Clear anodic coating, satin finish, except as scheduled otherwise.
      2) Exterior luminaires: Clear anodic coating.
8. Lens/Louver Frames:
   a. Extruded aluminum with mitered corners unless scheduled otherwise.
   b. Hinging or other normal motion shall not cause lens or louver to drop out.
   c. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
9. Lenses:
   a. Utilize 100 PCT virgin, UV stabilized acrylic.
   b. The lenses shall be held securely in place but must also be removable to clean and service the luminaire.
      1) Luminaires with a spread lens shall also include a lens orientation device to ensure that it is not affected during cleaning or relamping.
   c. There shall be no light leaks between the lens and the luminaire.
   d. Acrylic lenses and diffusers shall be properly cast, molded or extruded as necessary to meet the intent of the specified optics, and shall remain free of any dimensional

instability, discoloration, embrittlement, or loss of light transmittance at least for the period of the Manufacturer's warranty.

10. Reflectors:
    a. High-purity No. 12 aluminum reflector sheet, 0.047 IN or heavier if specified, free from fabrication or assembly damages. No exposed rivets, springs or other hardware after installation. Shape reflectors in modified elliptical or parabolic contour to produce no apparent brightness.
    b. Downlight reflector and baffle finishes: First-quality Alzak anodized specular or semi-specular finish of color as specified, unless otherwise noted in Lighting Fixture Schedule.
        1) Downlight reflectors shall be securely fastened but also removable for cleaning and relamping.
    c. Troffer reflector finish: integral reflectors shall be painted white after fabrication and shall have a minimum reflectance value of 90 PCT.
11. Gaskets: Provide gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and which allow interior access. Provide moisture seal gaskets at exterior locations and in other areas designated. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks. See Lighting Equipment Schedule for other types of seals and gaskets.
12. Ventilation: Provide ventilation openings of adequate size and quantity to permit operation of lamps/LED modules and ballast/driver without affecting rated output or life expectancy.
13. Lamp Holders:
    a. Position sockets so that lamps are in optically correct relation to luminaire components.
    b. Secure sockets by screws to luminaire enclosure. Spring mounted sockets are not approved. Do not use plastic or sheet metal sockets unless specified otherwise.
    c. Light Emitting Diode (LED): Unless otherwise specified, a dedicated means of connecting light source to power shall be used in luminaires purposely made for use with LEDs unless otherwise specified. LED modules shall be field replaceable.
14. Wiring:
    a. Factory wire luminaire to be compatible with project electrical and controls systems.
    b. Power supplies, unless otherwise specified, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
15. Mounting Accessories:
    a. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered. Provide fastening clips (seismic clips) for luminaires supported from framing members of suspended ceilings.
    b. Luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during relamping or cleaning.
    c. Recessed Luminaires:
        1) Plaster frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
        2) Baffles and gaskets: As required to prevent light leakage.
        3) Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
    d. Luminaire Suspension Material:
        1) Unfinished spaces: 1/2 IN minimum diameter pendant, unless otherwise noted.
        2) Finished spaces: Unless otherwise noted, provide manufactured cable or stem and outlet box canopy; contemporary design with swivel self-aligning features; size canopy to cover outlet box; finished to match luminaire. Coordinate pendant location with ceiling tiles/ceiling grid, and submit coordinated mounting accessories as part of Product Data submission.
            a) Provide luminaires mounted on suspended ceiling grids with outlet box designed for grid mounting with direct cord entry.

b) For high intensity discharge lamps, use stems suspended from swivel shock-absorbing fittings.

e. Mechanical Safety: Unless otherwise specified, retain luminaire closures (lens doors, trim frame, hinged housings, etc.) in secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

f. Luminaires in Hazardous Areas: Luminaires shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.

g. Compact LED luminaires shall be manufactured specifically for their respective light source with dedicated electrical connections and with power supplies integral to the fixture, except where remote devices are specified. Assemblies designed to retrofit incandescent luminaires are prohibited except when specifically indicated for renovation of existing luminaires. Luminaires shall be designed for lamps as specified.

h. The Contractor shall assure that all trims and canopies and escutcheons fit snugly and securely to the ceiling and/or wall so that no light leaks occur and so that no gaps or uneven waves are evident.

B. Lamps:

1. LEDs:

a. Color temperature specified shall be uniform for all LED modules within like luminaire types. Color temperature measurement shall have a maximum MacAdam Ellipse boundary of 3 SDCM unless otherwise specified in the Lighting Equipment Schedule.

b. Minimum Ra value or color rendering index (CRI) of 85.

c. LED light output and efficacy shall be measured in accordance with IES LM-79 standards.

d. LED life and lumen maintenance shall be measured in accordance with IES LM-80 and TM-21 standards.

1) Rated minimum L70 life of 50,000 HRS.

e. The individual LED's shall be connected such that a catastrophic loss or the failure of one LED will not result in a light output loss of the entire luminaire.

C. Drivers:

1. General:

a. Comply with UL and ANSI specifications. Enclosure shall display approval label for compliance with UL standards.

b. Contractor shall verify required voltage, frequency and power factors.

c. Comply with US Federal Efficiency Laws.

d. Manufacturing facilities shall maintain ISO 9001 certification.

e. Equipment shall not contain PCBs.

2. LED Drivers:

a. LED Dimming Driver.

1) 4-Wire (0-10V DC Voltage Controlled) Dimming Driver.

b. General.

1) LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.

2) Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 PCT (voltage and frequency) with no visible change in light output.

3) Total Harmonic Distortion less than 20 PCT and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
4) Driver shall have a Power Factor greater than 0.90.
5) Driver output shall be regulated to +/- 5 PCT across published load range.
6) Driver shall have a Class A sound rating.
7) Driver shall have a minimum operating temperature of -4 DEGF.
8) Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
9) Driver output ripple current shall be less than 15 PCT measured peak-to-average, with ripple frequency greater than 100 Hz.
10) Driver must limit inrush current and meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.
11) Driver shall withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A for Transient protection.
12) Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
13) Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
    a) Adjustment of forward LED voltage, supporting 3V through 55V.
    b) Adjustment of LED current from 200 mA to 1.05A at the 100 PCT control input point in increments of 1 mA.
    c) Adjustment for operating hours to maintain constant lumens (within 5 PCT) over the 50,000 HR design life of the system, and deliver up to 20 PCT energy savings early in the life cycle.
14) Driver: UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
15) Drivers shall have a rated life greater than or equal to the stated life of luminaire they control.
16) LED engine must be compatible with type of driver, and coordinated prior to submission of shop drawings.
17) Coordinate if lighting controls utilize source or sync dimming. Luminaire manufacturer shall provide converter pathway device(s) as required for luminaires to dim and function as specified.
18) Fixture shall be properly heat-sinked to assure LED junction temperature ratings are not exceeded. Manufacturer shall provide ambient operating temperature range for which product is warranted.
19) If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires. Driver shall be housed in NEMA enclosures so rated for the power supply and located in code-compliant, sound-isolated, well-ventilated, easily accessible areas. Size wire according to run length and LED Manufacturer's size and distance-of-run requirements and in accordance with code requirements.
20) All LED power supplies shall be suitably sized to accommodate the LED array consistent with industry standards, including IEC standard 60929 Annex E.
21) Driver shall be available in an all metal-can construction for optimal thermal performance.
22) Driver shall be provided with integral color-coded connectors.
23) Provide with mounting hardware as required.

c. Light Quality.
    1) Over the entire range of available drive currents, driver shall provide step-free, continuous dimming. Driver shall respond similarly when raising.

a) The luminaire shall be capable of continuous dimming over a range of 100 PCT to 10 PCT of rated lumen output.

2) Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.

3) Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

4) Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 PCT luminaire shall have:
   a) LED dimming driver shall provide continuous step-free, flicker-free dimming similar to incandescent source.
   b) Flicker index shall be less than 5 PCT at all frequencies below 800 Hz.

d. Control Input.
   1) 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers.
      a) Must meet IEC 60929 Annex E for General White Lighting LED drivers.
      b) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
      c) Must meet ESTA E1.3 for RGBW LED drivers.
      d) Driver shall utilize fully isolated 0-10V control inputs. 0-10V input shall be protected from line voltage miswire, and shall be immune and output-unresponsive to induced AC voltage on the control leads.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate luminaire mounting and trim type with architectural reflected ceiling plans, suspended ceiling grid and ceiling tile specification, and room finish schedules prior to submission of shop drawings.
   1. Advise Architect of any discrepancies.

B. Coordinate required above-ceiling clearances of recessed luminaires with ductwork and piping.
   1. In exposed ceiling areas, coordinate luminaire locations, mounting heights, and supports with other trades.

C. Coordinate, review and approve fixture locations shown on acoustical ceiling shop drawings prior to submission.
   1. Notify Architect of any discrepancies with lighting plans and review coordinated ceiling shop drawing review comments.

D. Coordinate lighting control devices with fixture ballasts and drivers. Advise Architect of discrepancies prior to submission of shop drawings.

3.2 INSTALLATION

A. Strictly follow the manufacturer's directions for installation of all lighting equipment. Assemble and wire luminaires, with lamps, in such a manner to ensure correct operation.

B. Locate luminaires in accordance with architectural reflected ceiling plans.
   1. Where luminaires are installed in acoustical tile ceilings, locate in exact center of tile unless indicated otherwise. Relocate misplaced luminaires and replace damaged ceiling materials.
   2. Where field conflicts exist, coordinate relocation of equipment with Architect.

C. Mount luminaires at heights indicated in Section 26 00 10 and as indicated on drawings. Where field conflicts exist, or mounting height is not stated, coordinate with Architect.

D. Verify structural support is adequate to ensure luminaires are supported to maintain level and alignment.

E. Add two 12 GA steel wire safety hangers for luminaires weighing less than 56 LBS connected from opposite, diagonal ends of fixture housing to structure above in addition to support requirements specified and recommended by manufacturer.
   1. These wires may be slack.

F. Support luminaires weighing 56 LBS or more directly from structure with approved hangers.

G. Design support system for custom products and lowering devices by licensed structural engineer based on fixture being installed.
   1. Submit installation instructions and details for information only as part of fixture shop drawing review process

H. Provide hangers with enclosure rating, NEMA 1, 4, 4x or 7, equal to enclosure requirements of area in which they are installed.

I. Ground luminaires per NEC Article 410.

J. Provide exit sign at exit locations, with mounting type, number of single or double faces, and directional arrows (chevrons) as required for exiting.
   1. Where exit signs are pendant mounted, provide manufacturers pendant mount stem kit.
   2. Do not mount sign housing to junction box suspended by conduit.

K. Orient horizontally positioned fluorescent lamps or LED circuit boards of luminaires within a single room in same direction unless indicated otherwise.

L. Seal luminaires for wet locations (i.e. knock-outs, pipe and wire entrances) to prevent water wicking.

M. Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Architect and which does not void warranty.

N. Install reflector cones, louvers, baffles, lenses, trims and other decorative elements after completion of ceiling tile installation, plastering, painting and general cleanup.

O. Recessed Luminaires:
   1. Verify mounting details for each space; provide correct luminaire flange mounting accessories for each condition.
   2. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold-down clips and to building structure with two No. 12 GA steel hanger wires connected to opposite corners of the luminaire.
      a. Each hanger shall have the capacity of 100 PCT of luminaire weight acting in any direction.
   3. Support downlights and exit signs with rails spanning between runners of suspension system.
   4. Coordinate to ascertain luminaires are furnished in sizes, with flange details, and installed with the devices (hangers, clips, trim frames, flanges), to match ceiling system being installed.
   5. Support troffers in gypsum board ceilings from structural framed openings with adjustable lugs on side of luminaire or yoke mounting as recommended by luminaire manufacturer.
      a. Where structural framed openings are not provided, fixtures must be independently supported from structure.
      b. Suspended grid systems for gypsum board ceilings are not approved structural support systems for luminaires.
   6. Support downlights and troffers in metal pan and gypsum board ceilings from plaster frames.
   7. Use unwired or pre-wired luminaires as required.

a. Do not use pre-wired luminaires for through-wiring unless UL approved for the purpose.

8. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
   a. See Section 26 00 10.
9. Wherever recessed luminaires are installed in insulated ceiling systems, it is responsibility of the Contractor to construct above-ceiling enclosures around non-insulation-contact-rated equipment to provide at least 3 IN or airspace on each side of the luminaire.
10. Trims shall fit plumb and flush with ceiling or wall surface.
11. There shall be no light leak around interface between lens door or holder trim flanges and ceiling or wall.
12. Coordinate trimless or flangeless luminaires with other trades to achieve a trimless/ flangeless installation.
    a. Provide a level 5 finish at drywall or plaster ceilings/walls unless otherwise directed by Architect.
    b. In drywall, plaster, wood, or stone, special luminaire collars and exacting coordination are required.

P. Surface Mounted and Pendant-Hung Luminaires:
1. Attach surface mounted lighting luminaires to ceiling system with positive clamping devices that completely surround supporting members.
   a. Attach safety wires between clamping device and adjacent ceiling hanger or to structure above.
   b. Do not exceed design carrying capacity of supporting member for luminaire load.
2. Support pendant hung lighting luminaires directly from structure above, using 9 GA steel wire, without relying on ceiling suspension system for support.
3. Pierce ceiling material for hangers and outlet boxes as required.
4. Do not remove ceiling material above surface mounted luminaires.
5. Hang luminaires plumb with continuous rows in alignment.
6. Unless otherwise noted, suspend luminaires in each room or area at same height regardless of varying clear height conditions.
   a. Provide stem lengths as required.
7. Cord of pendant fixtures must enter directly into approved wiring box without passing through plenum, in accordance with NEC.
8. Provide suspended luminaires with flexible cord.
   a. Flexible cord shall connect to a junction box located directly above luminaire feed point.
   b. Flexible metal conduit and luminaire whips are not allowed for suspended luminaires.
   c. Trim cords to length, and attach to suspension cable at regular intervals.
   d. Do not coil flexible connections.
9. Surface or pendant luminaires mounted end to end shall have flat end caps to assure flush alignment and shall be UL listed for through wiring.
10. Provide pendant cylinder luminaires with swivel hangers which allow luminaire to swing in any direction but not permit stem to rotate.
11. In mechanical, electrical and storage spaces, pendant mounted, open industrial luminaires, not in continuous rows, shall be supported by conduit or metal channel, similar to Unistrut, and All Thread.
    a. Pendant mounted luminaires in continuous rows shall be fastened to each other or mounted on continuous metal channel.
    b. Provide reflector alignment clips on industrial luminaires mounted in continuous rows.
12. Contractor shall provide and/or coordinate additional bracing in wall or above ceiling as required to support fixture in accordance with manufacturer's recommendations.

Q. Continuous Luminaire Patterns:
1. Fasten sections together for continuously aligned appearance, with no dimpling or light leakage.

a. Provide end extensions where required.

2. Where luminaires run continuously around inside or outside corners, provide prefabricated illuminated corner pieces.
   a. Run luminaire lenses, baffles or louvers continuously with luminaire.
   b. Miter and/or fan at corners as directed.
3. Where lenses are used, open gaps shall not be visible.
   a. Solid-state luminaires shall utilize mitered or rabbited lenses to prevent direct view of modules.
   b. Maximum visible gap between the edge of lens and the end of luminaire trim is 1/16 IN, and not allow direct view of solid state modules.
4. Only where continuous runs do not end at a wall or fascia, provide a finished end plate, with no visible holes and concealed fasteners.
5. Provide a continuous light appearance over total length of assembly.
   a. The luminaire shall run continuously wall to wall or wall to corner without a gap at either end of the fixture when located adjacent to a wall or corner. The maximum permitted non-illuminated length at either end shall not exceed 6 IN.
   b. For fluorescent fixtures, utilize 3 FT and 4 FT linear lamps wherever possible.
      1) Where required, provide a 2 FT lamp in spaces less than 3 FT in length.
   c. For continuous direct fluorescent fixtures, overlap sockets to prevent socket shadows.
6. Cove luminaires in architectural coves shall be installed continuously with no gaps between luminaires.
7. Coordinate installation and requirements of undercabinet luminaires with casework installation.
   a. Provide separate segments of luminaires if luminaires cannot run continuously beneath cabinet.
   b. Conceal wiring and conduit to luminaires.

R. Lighting Track:
1. Mount lighting track as scheduled.
2. Connect building wiring to conductors in track at outlet box.
   a. Install lighting fixtures on track where instructed.
3. Provide framing member above suspended ceiling to support track.
   a. Extend framing member full length of track; attach track securely.
   b. Pierce ceiling material as required for supports.
   c. Provide sway bracing so lighting track remains stable when lighting fixtures are inserted or removed.

3.3 COMMISSIONING

A. Coordinate lighting operations, including support from Luminaire and Controls Manufacturers, with commissioning and controls.

B. Synchronize fully functional lighting and lighting controls systems to address lighting operation in complete and code compliant manner.

C. Provide documentation related to commissioning, including record drawings identifying luminaire control loops and addresses with respect to specific luminaire types and Initial Preset Schedule Spreadsheet.

3.4 ADJUSTABLE FIXTURES

A. Aiming shall occur upon Substantial Completion of project including, but not limited to, installation of artwork, millwork, furniture, and plantings.

B. Aim adjustable fixtures as directed.

C. Perform this work at night, outside of normal working hours, with no light from stray sources.

D. Use light meter to obtain as even a distribution as possible.

E. Aiming shall occur upon substantial completion of project including, but not limited to, installation of all artwork, millwork, furniture, and plantings.

F. Coordinate a time with Architect and Owner, to make final adjustments to aiming.

G. Provide ladders, scaffolding, lifts and tools required for accessing and aiming fixtures, and coordinate this activity based on site availability of Lighting Designer.

3.5 RELAMPING AND CLEANING

A. Replace inoperable lamps.

B. Align luminaires and remove paint splatters, dirt and debris.

C. Touch up any visible damages to luminaire finish.

D. Wipe clean luminaire reflectors, lenses, lamps and trims, after installation.

E. Install luminaires with caution to avoid fingerprints or smudges on surfaces of parabolic louvers and downlight reflectors.
   1. Use cleaning materials and methods that will not damage finish.
   2. Where fingerprints or smudges cannot be adequately removed, replace affected luminaire.

F. Install architectural cove luminaires after cove has been painted.
   1. Vacuum construction debris from cove to ensure a dust-free reflector surface prior to date of Substantial Completion.

3.6 SPECIAL PROTECTION

A. Remove protective covers immediately prior to date of Substantial Completion.

3.7 REPLACEMENT STOCK

A. Provide Owner's initial lamp replacement stock.
   1. Provide 5 PCT of each lamp type but not less than 10 or more than 60 of any one type.
   2. Match lamps exactly with types specified and provided for installed luminaires.

B. Provide Owner LED boards or modules to replace the LEDs in 2 PCT of luminaires, but no fewer than 5 and no more than 30 of luminaire types using identical LED's. For luminaires that are longer than 8 FT in length. Modules to replace one 8 FT length shall be considered sufficient. If the exact same modules are used in multiple luminaire types, maximum quantity of modules/ boards to replace 30 luminaires of most type is sufficient cover all types.
   1. If LED's are irreplaceable and an inherent integral part of luminaire, no spares will be required unless otherwise indicated in Lighting Equipment Schedule.

C. Provide Owner 2 PCT of each ballast/ driver/transformer type but not less than 5 or more than 30 of any one type.
   1. Match ballasts exactly with types specified and provided for installed luminaires.

D. Warranty replacements are not be taken from replacement stock.

END OF SECTION

SECTION 28 05 00
BASIC ELECTRONIC SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECURITY SYSTEM DESCRIPTION

A. This Section covers the University's Access Control System (ACS). If required by the Project Program, ACS shall link with the existing campus central station control and alarm monitoring system which is located within the University Police Department. The central station system is monitored by campus police dispatch center.

B. Provide the detail design of the system, furnish and install hardware, modify the existing campus central station database and software as required to accept this building, start-up and commission the system, and then warrant the completed system including equipment, appurtenances, and existing campus central station modifications.

C. The ACS shall include, but not be limited to, necessary hardware, existing campus central station hardware and/or software modifications, remote alarm terminal printer, initial database programming, floor terminal controllers, door smart terminal interface panels, door alarm/status sensing devices, access cards, card readers, exit request push-button stations, step-down power supply transformers, conduit, wire and cable, communication devices (modems) required to enable the building to communicate with and receive data from the existing campus central station.

D. The identification and location for security access is shown on the drawings.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and install an access control system including necessary hardware and software to perform the functions intended in accordance with the specifications.

B. The system shall be fully integrated to the existing campus Cardkey security system and the existing hardware and software shall be modified to include the extended system.

C. The system shall provide all functions required by the university as specified by Facilities Services Administration, Key and Lock Shop supervisor. Contact the Key and Lock Shop Supervisor for specific details.

D. Operation of a valid card on an access control reader shall release the lock mechanism for a preset time.

E. Request to exit as detected by the motion sensor shall release the lock mechanism for a preset time.

F. While the lock mechanism is released, the alarm contacts shall be shunted to prevent an alarm.

G. If the alarm contacts are opened or are not closed at the end of the lock release preset time, a local alarm shall sound. This alarm shall be repeated to the control security station.

H. Card readers in elevator cars shall be linked to elevator controls to allow travel to selected floors. The system shall be capable of restricting access to floors not permitted by the access card.

1.3 QUALITY ASSURANCE

A. References:
   1. Published specifications, standards, tests and codes and recommended standards of trade industry or governmental organizations apply to Work in this Section including:
      a. Federal, state and local codes, regulations and ordinances.
      b. Underwriters Laboratories, Inc. (UL) requirements.

c. NFPA-70 National Electrical Code (NEC).
d. California Electrical Code (CEC).
e. Occupational Safety and Health Act (OSHA).
f. All authorities having jurisdiction.
g. International Building Code (IBC).
h. California Building Code.
i. State of California Administrative Code.
j. NFPA-72: Installation, maintenance and use of protective signaling systems.
k. California Fire Code
l. UC Riverside Standards

2. Electronic devices radiating "RF" energy shall comply with Federal Communication Commission regulations, particularly Part Fifteen, and shall meet minimum Class "B" requirements. Provide FCC certificate numbers indicating that the FCC has approved the products.

B. Qualifications:
1. The installation contractor shall have an established engineering, sales, installation, and service presence within Southern California. This office shall have been in operation for a period of not less than five years prior to the bid date of the project.
2. The Installation Contractor shall be a Branch office, a Main Office, or an authorized dealer and/or Installer of the system manufacturer and shall have done at least two (2) projects similar to this project in size and type in the last three (3) years.
3. The Installation Contractor shall be responsible for the complete installation and proper operation of the ACS, including the initial data input, system debugging, and initial calibration of system components.
4. A full-time Project Manager with a minimum of five (5) years' experience with facilities of this size project and complexity shall be assigned to manage both the engineering/design and system installation/start-up phases of the projects. Close coordination and approval from and with the Design Professional is required.

1.4 SUBMITTALS

A. Shop Drawings: Drawings shall show device locations, riser diagram, devices, and other requirements of this Specification and connection to the central monitoring system
1. Wiring Diagrams:
a. Show terminal to terminal connections between components.
b. Identify each circuit and component by name or number referenced to Contract Documents.
2. Control Panel Drawings:
a. Show physical dimensions, power requirements, component layout, and provisions for expansion if specified.
b. Provide battery standby calculations.
3. Sequence of Operation:
a. Describe operation in either a narrative or matrix format.

B. Product Data:
1. Submit Manufacturer's original printed data sheets showing physical dimensions, performance data and listings/approvals.
2. Submit data sheets for products furnished under this Section, whether or not they are referenced in Contract Documents.
3. Where data sheets show multiple product items, highlight data pertinent to products being furnished.

C. Project Information:
1. Supplier qualifications certificates and documentation.
2. Contractor qualifications certificates and documentation.
3. Manufacturer's installation instructions.

D. Contract Closeout Information:
   1. Demonstration and training completion statement from Owner.
   2. Project Record Documents:
      a. Using shop drawings, show wiring and layout drawings to record actual construction.
   3. Completed copy standard field test report. Record all tests and system calibration using the standard commissioning form.
   4. Inspection certificates from authorities having jurisdiction.
   5. Operation and Maintenance Data:
      a. Requirements and recommendations related to maintenance.
      b. Manufacturer's user training manuals.
      c. See Section 01 77 00.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. The Access control system shall comprise the following principal hardware.
   1. Intelligent Terminal Controller to support the Smart Terminal Interface Programming Equipment and communications with the existing central controller. Controller shall have a battery sized to provide six hours of power in event of primary power failure.
   2. Smart Terminal Interface units for connection of door hardware and access reader.
   3. Card Readers shall use equivalent or better technology as used on the campus. Card readers shall be suitable for their installed locations
   4. Access cards shall be Weigand "effect" security cards as used on the campus. Access cards shall be provided with the system preprogrammed with the University's facility code.
   5. Door hardware shall consist of:
      a. Electric strikes as furnished in door hardware. Verify the strikes' power and connection requirements and provide equipment necessary to interface with the electric strike. Coordinate and provide necessary hardware for connection to any automatic disabled access control doors.
      b. Request to exit shall consist of a motion sensor mounted above the door.
      c. Door alarm contacts shall be coordinated with the door construction.
      d. Door alarm sounder shall be provided by each access control door to signal an alarm condition at that door.
      e. Where an access control door is installed on a means of escape, an emergency pull station shall be provided. The pull station shall release the door lock and signal an intrusion.

B. The central control panel shall have and network card to allow connection to the campus network. Security system wiring shall be segregated from other systems. The central control panel shall be located in the MDF telephone room and include a hinged, lockable cover.

C. Security systems shall be as specified in the following table:

Controllers	Shall be IdentivHirsch UTRUST Model M8N2 with downloadable firmware to protect panel from becoming obsolete. Firmware must be latest revision at time of installation.
Card Readers	Shall be Identiv-Hirsch Models TM110 wall mount or TM15 mullion mount unless otherwise specified by the campus Lockshop.
Reader Mounting boxes	Shall be flush mounted unless existing construction prohibits then surface mount may be substituted.
Line Modules	Shall be Hirsch model MELM-2.
Door Contacts	All doors shall have door position switches and they shall be flush mount type unless construction prohibits then surface mount may be substituted.

Request to exit sensors	All doors shall have RQE sensors and they shall be motion activated with ability to select area of coverage. Openings with panic hardware RQE function may be incorporated in panic bar with switches.
Computer workstation	Shall be compatible with Hirsch Velocity software current version. See Hirsch Electronics for current computer specification. Computer to be delivered directly to campus Lockshop.
Handicap operators	Doors with handicap operators shall be wired with handicap operator on one relay and locking hardware on a separate relay.
All installations	Must communicate over campus network through Velocity software to campus card access central servers.
Panel Location	All control panels and related items shall be mounted in IDF or other rooms NOT IN ELECTRICAL ROOMS.
Keypads	Shall Be Identiv-Hirsch Scramble pad DS47HI for exterior and DS47L for interior doors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide conduit and wire from dedicated 120 VAC power circuits.

B. Power supply wiring (120 VAC) shall be run in dedicated conduit. Power conduit shall be separated from control and signal conduits by a minimum of 3 inches.

C. ACS equipment shall be located such that it is accessible for service while maintaining clearances or walkways required around other equipment or obstacles.

D. Control elements located in outdoor installations shall be weatherproof.

E. Splices in shielded cables shall not be permitted. Terminations of shields and conductors shall be done in accordance with the manufacturer's instructions.

F. Cabling and wiring within panels shall be harnessed with tie wraps and secured in a neat and orderly fashion.

G. Cable runs shall be kept as short as possible, allowing extra length for making connections to termination points.

H. Each cable or individual conductor shall be labeled with a unique tag for quick identification during checkout, testing, and troubleshooting. Each component shall be permanently labeled with the device name and at each terminal point per Division 26.

3.2 SYSTEM TESTING AND CHECKOUT

A. Prior to the acceptance test, the contractor is to perform the following tasks:
1. Check for electrical continuity, eliminating shorts and open circuits, and verify grounding.
2. Install, calibrate, adjust, debug and set system's initial operating parameters including the existing campus central station.
3. Check out systems to verify the provided engineering documentation and approved submittals have been followed.
4. The ACS, including the interface with and programmed responses of the existing campus central station, must operate continuously for seven (7) days with no operational malfunctions or problems before setting an acceptance test date. Simulate different access and egress scenarios for worst case condition and simulate other alarm conditions to test the ACS's response and handling of situations. Keep a detailed log of tests conducted, problems encountered, and the corrective action that was taken.
5. Prepare and submit an Acceptance Test Plan for approval. This test shall include verification of communications, control, and response from the existing campus central station to a floor terminal controller, to a smart terminal interface, and finally to the sensor and controlled device to demonstrate the proper operation of control loops, conditional control and default sequences in accordance with the project documentation.

6. Obtain the approval of the University's Representative as to when the acceptance test will be performed.
7. Conduct the acceptance test in the presence of the University's security supervisor and/or of their designated Representative, following the approved Acceptance Test Plan.
8. The University's Representative shall check off and initial each successfully tested item. Demonstrate that the electromechanical systems are operating properly, and that the system is providing the required control sequences, alarms, graphic displays, and report generations.
9. An ongoing punch list shall be maintained throughout the test of items. This list shall contain items that must be corrected prior to accepting the system for beneficial use and commencement of the warranty period.

B. Training
1. Furnish the services of competent instructor(s) who shall give a maximum of four hours instruction and orientation to the University's designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements of the equipment, the affected systems, and the software provided. The training shall be customized to reflect the actual system installed rather than being a general (canned) training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach.

END OF SECTION

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SECTION 28 31 13
FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Fire Alarm and Detection System (FAS), as indicated, in accordance with applicable codes and provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Reference Standards:
1. NFPA 13: Standard for the Installation of Sprinkler Systems.
2. NFPA 20: Standard for the Installation of Centrifugal Fire Pumps.
3. CFC: California Fire Code.
4. NFPA 72: National Fire Alarm Code.
5. NFPA Formal Interpretations for the above.
6. CBC Title 24
7. Designated Campus Fire Marshal (DCFM) requirements
8. ANSI A17.1, Safety Code for Elevators, Dumb Waiters, Escalators and Moving Walks.
9. UL 864 9th edition
10. CFC: California Fire Code

B. Qualifications of Supplier:
1. Acceptable to manufacturer to furnish products specified, employing personnel trained by manufacturer.
2. Furnished identical products for a minimum of three systems of similar scope with the same equipment, which are currently in service.
3. Parts and service availability within a 30 mile radius of the Project on a 24 HR, 7 day a week basis.

C. Qualifications of Contractor:
1. Company licensed in project State to perform detailed design of FAS including application of specific products, preparation of shop drawings and supervision of installation.
2. No less than five (5) years of documented work experience on projects of equivalent size and similar scope.
3. Installed and completed installations of a minimum of three similar systems, with system being successfully operated by the Owner for its intended purpose for minimum one (1) year.
4. Employ experienced personnel qualified to design and install fire alarm systems of scope and complexity within jurisdiction of Fire Department.
   a. Knowledgeable in regard to governing codes and regulations regarding fire alarm system design and performance.
   b. Project State Licensing and NICET level III certification.
5. Perform work, including electrical rough-in, under supervision of personnel who are familiar with the codes and standards that govern installation of these systems.
6. A complete system is required which meets the DCFM, Codes and ADA requirements.

1.3 SYSTEMS DESCRIPTION

A. Fire alarm systems are to be Simplex 4100 Series. The existing system is a Simplex 4020.

B. The new scope of this project is an extension of the existing system in the building. The existing system will be left in place with the new system integrated into it. The intent is for the new

4100ES series to facility any newly renovated areas and eventually replace the existing 4020 system as a part of future building tenant improvements. The system shall be capable of being expanded at any time up to the pre-determined maximum capacity of the system.

C. Existing notification and initiation devices shall be replaced with new. The existing wiring may be reused if the integrity of the circuit is validated.

D. The new system shall consist of local fire control panel equipment, audio alarm transmitter, Digital Automated Communication Terminal (DACT), campus GCC network interface card and fiber media cards (future use), automatic detection devices, manual reporting stations, speakers, visual alarms, a separate fireman's communications system shall be provided as required, and wiring. The entire system shall be equipped with an emergency battery back-up system. The control panel shall be located as shown. The fire alarm annunciator panel shall be placed on building where shown.

E. Provide UL listed system, engineering, electrical installation, detection and control equipment, auxiliary devices, alarm interface, functional checkout and testing, training and operations necessary for a functional system.

F. FAS shall be a local, non-coded, protected premises fire alarm system including manual fire alarm, automatic fire alarm, sprinkler waterflow alarm, sprinkler supervision, and selective sounding emergency voice/alarm communication system services.
   1. Microprocessor-based fire alarm control panel with addressable device interface, controls, amplifiers and power supply modules.
   2. Distribute additional visual alarm notification appliance circuit power supplies throughout building.

G. Fire Alarm Control Panel (FACP) shall be located as indicated on the drawings and shall be equipped for annunciation of system alarm/supervisory/trouble signals, control of specified building equipment as specified in this Section and command of voice alarm/signaling system.

H. Provide primary human interface to the system at FACP including an LCD display and logging printer to describe nature and location of abnormal (alarm, supervisory and trouble) conditions. Provide facilities for manual control of alarm notification appliances and stair door unlocking at FCS.

I. Provide interfaces to HVAC equipment for fan shutdown and Building Automation System (BAS) for prevention of spread of smoke including smoke control operation.

J. Fire Alarm Remote Annunciators (FANN) with alpha-numeric LCD display of system activity and microphone station shall be located where shown.

K. Fire Alarm Graphic Annunciator Panels (FGAP) including discreet LED’s annunciating alarm points and map of the building shall be located where shown.

L. Fire Department notification shall be by means of a Digital Alarm Communicator Transmitter (DACT) using the public switched telephone network to communicate with a UL listed central station.

1.4 PERFORMANCE REQUIREMENTS

A. Fire alarm control equipment locations shown on plans reserve space in the building for fire alarm equipment.

B. Configure equipment provided at each location shown to fit within space shown on Drawings in locations reserved for fire alarm equipment.

C. The control panel shall provide an enhanced CPU with dual configuration programs and capacity for up to 2000 points. The system power supply and charger shall provide at least 9 Amps of on-board and 3 on board NAC circuits. Provide 25% additional capacity on all designed circuits.

D. Initiating device circuits (IDC), notification appliance circuits (NAC) and signaling line circuits (SLC) shall perform as defined in NFPA 72 for Classes and/or Styles of operation noted on contract drawings and limited to serving areas shown on contract drawings unless otherwise noted.

E. 24Vdc power wiring for equipment requiring external power and connected to a Class A wired IDC, NAC or SLC shall have same degree of reliability as the IDC, NAC, or SLC connected to equipment.
   1. Install 24Vdc wiring in Class A fashion and arranged so a single fault on 24 VDC power supply conductor shall initiate a trouble signal but not result in loss of functionality of any device on circuit.

F. Except for NAC's, loading of any circuit, including building control circuits, shall not exceed three-fourths of the rated capacity of the circuit in terms of power loading, address availability.
   1. Permit SLC's to serve multiple floors, provided that each SLC is provided with short circuit isolation modules which prevent a short circuit on one floor from affecting the operation of other floors.
   2. Loading of NAC's for visual alarm notification appliances shall not exceed two-thirds of rated capacity of circuit.
   3. Loading of NAC's for audible alarm notification appliances shall not exceed half of the rated capacity of the circuit.
   4. Provide at least two NAC's per floor for audible alarm notification appliances.

G. Power supplies shall not be loaded beyond two thirds of their rated capacity.

H. Audible and visual alarm notification appliances shall be grouped into zones organized by floor, by stair, and by elevator cab.
   1. Permit multiple circuits in a single notification appliance zone to service equipment load in the zone, but all operate together as one within the zone.
   2. Provide each floor with minimum of 2 NAC's for audible alarm notification appliances arranged so adjacent appliances are wired to alternate circuits.

I. Standby batteries shall be calculated to provide operation of all equipment specified in this Section in a supervisory mode for 60 HRS, followed immediately by 15 minutes of alarm operation with power supplies and audio amplifiers at full rated output for "all call operation".

J. In recognition that both audible alarm appliance efficiencies and how their sound outputs are stated differ among manufacturers, the application engineer producing the shop drawings shall select appropriate speakers power taps so that measured sound levels in actual installation meet or exceed the requirements of governing codes and standards.
   1. Indicate speaker taps settings for each speaker and total load for each NAC.
   2. Provide amplifier capacity equal to total anticipated speaker loads plus a 100 PCT reserve or plus a reserve capacity of 1 Watt per 1000 SQ FT of gross floor space whichever is greater.

K. Provide at least one standby amplifier for each channel at each amplifier location to be automatically switched into system to replace a failed unit.

L. Relay contact ratings of fire alarm equipment shall be adequately rated for intended use.
   1. Where control unit relay or addressable relay contacts are not adequately rated to handle load, provide auxiliary relays that are adequately rated.

M. If the successful fire alarm manufacturer and building automation system (BAS) manufacturer have the ability to share alarm information from the fire alarm system on the BAS using a UL listed gateway, such an arrangement shall be permitted to be used in lieu of discrete addressable relays shown for this purpose.
   1. This does not apply to addressable relays connected to VFD's for fan shutdown.

N. Switches and LED indicators in the section of systems operation shall be individual discrete units clearly labeled as to function.
   1. Multifunction keypads and scrolling alphanumeric type displays shall not be used in lieu of discrete switches and LED indicators for specified operations and indications.

O. A multiplexed fire alarm system with remote transponders or nodes distributed throughout the building shall be permitted in lieu of the single central FACP system design shown provided that the multiplexed system complies with all regulations set forth in applicable codes and local ordinances governing multiplexed fire alarm systems.

P. Surge Protectors:
   1. Protect cables and conductors which serve as communication, control, or signal lines against surges and shall have surge protection installed at each end.
   2. Furnish protection at equipment and additional triple electrode gas surge protectors rated for application on each wireline circuit shall be installed within 3 FT of building cable entrance.
   3. Fuses shall not be used for surge protection.
   4. Test inputs and outputs in both normal mode and common mode using following waveforms:
   5. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
   6. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.5 SYSTEMS OPERATION

A. The system wiring shall be a Class "B" wiring system unless noted otherwise. Labs shall be Class “A” indicating circuits. Loss of any conductor shall not prohibit alarm initiation from any initiating device or alarm indication from any alarm device.

B. The system shall function as follows when any smoke detector, duct detector, manual station or water flow switch operates:
   1. Sound the audio alarm and cause visual signals to flash throughout the entire building.
   2. Automatically notify the Campus Police Dispatch Center.
   3. Display individual detector number on GCC with Owner’s Representative defined message.
   4. Print individual detector number with defined message, date, and time on Network printer terminal.
   5. Light an indicating lamp on the device initiating the alarm or on the device remote indicator.
   6. Shut down the HVAC system, except for a building with chemical fume hoods.
   7. Activate elevator recall and alternate recall sequences when the associated smoke and/or heat detector(s) are in alarm.
   8. Close magnetically held fire doors and/or smoke dampers.
   9. Unlock security doors.

C. Except where cross-zone operation is required, smoke detector alarms shall be subject to an "alarm verification feature" defined in NFPA 72.
   1. Verification time periods shall be in accordance with manufacturer's UL listing for this feature.
   2. Other alarm initiating devices and smoke detectors required for cross-zoned operations shall not be subject to alarm verification.

D. Receipt of a signal indicating an abnormal condition regarding a device or a circuit, i.e., a fire alarm signal, a supervisory signal or a trouble signal, shall cause an audible signal to sound at the fire alarm control panel at the FCS accompanied by a visual alarm display which identifies the source of the signal.
   1. Acknowledging the fire alarm shall silence the local audible signal at the FCS and cause visual alarm display to remain until system is reset.
   2. Alarm, supervisory and trouble signals shall be transmitted to the designated central station receiving agency and Owner’s on site alarm monitoring station.

E. Receipt of an alarm signal from any spot type smoke detector, air sampling type smoke detector, duct mounted smoke detector, heat detector, manual fire alarm station, clean agent suppression system control panel, preaction sprinkler control panel or sprinkler waterflow switch shall cause:
   1. Audible and visual alarm notification appliances in the programmed alarm notification zones to operate in accordance with the sequence for high rise occupancies.
   2. Door lock release relays to operate to remove power from stair door locks to unlock them without unlatching.

F. Receipt of an alarm signal from any air duct mounted smoke detector shall cause:
   1. Operation of an addressable relay to signal the VFD of the affected air handling unit to stop the unit.
   2. Operation of an addressable relay to signal the BAS that the specific fan has been stopped due to smoke detection.

G. Receipt of an alarm from a spot type smoke detector or an air sampling type smoke detector in the Mechanical Penthouse shall cause:
   1. Operation of an addressable relay to signal the VFD for AHU-MECH to stop.
   2. Operation of an addressable relay to signal the BAS that the AHU has been stopped due to smoke detection.

H. Elevator Recall:
   1. Receipt of an alarm signal from an elevator recall smoke detector in an elevator lobbies not on the main recall floor shall cause a signal to be sent to the elevator controller for the affected elevator(s) to initiate recall to the designated main recall floor.
   2. Receipt of an alarm signal from an elevator recall smoke detector in an elevator lobby on the main recall floor shall cause a signal to be sent to the elevator controller for the affected elevator(s) to initiate recall to the designated alternate recall floor.
   3. Receipt of an alarm signal from an elevator machine room smoke detector or hoistway shall cause signals to be sent to the elevator controller for the affected elevators to initiate the fireman's warning signal within the elevator cab.

I. Operation of FACP switches shall permit automatic AHU shutdown signals to be overridden, i.e. to manually initiate operation of addressable shutdown relays or to manually restore shutdown relays operated automatically as a result of smoke detection.

J. LED indicators on the FACP shall indicate the status of the shutdown relays.

K. Operation of FACP switches shall permit selective transmission of automatic messages/tones and live voice announcements to any individual alarm notification zone.

L. LED indicators on the FACP shall indicate which notification zones are receiving audio.

M. Operation of an FACP switch marked "unlock stair doors" shall operate addressable door release relays associated with locked stair doors.

1.6 SUBMITTALS

A. Shop Drawings: Drawings shall show device locations, riser diagram, devices, and voltage drop calculations, other requirements of this Specification, and connection to the central monitoring system.
   1. Wiring Diagrams:
      a. Show terminal to terminal connections between components.
      b. Identify each circuit and component by name or number referenced to Contract Documents.
      c. Identify unused circuits.
      d. Show manufacturer's part number, AWG size, construction, insulation type and rating for conductors and cables.
   2. Floor Plan Layout Drawings:
      a. Show location of all equipment required for operation, whether or not referenced in Contract Documents.

b. Indicate IDC's, NAC's, SLC's and building control circuits connected to each piece of equipment.
c. Indicate the UL1971 intensities of visual alarm notification appliances at each location.

3. Control Panel Drawings:
   a. Show physical dimensions, power requirements, component layout, and provisions for expansion if specified.
   b. Identify terminals for each IDC, NAC, SLC and building control circuit and provide a tabulation of the load on each circuit to show that circuit loading is within the specified limits.
   c. Provide battery standby calculations.
4. Sequence of Operation:
5. Describe operation in either a narrative or matrix format.
6. Describe functions of each individual input and output which does not function on a system or global basis.
7. Labeling:
   a. List of display messages and printed labels as they will appear in completed installation.

B. Product Data:
1. Submit Manufacturer's original printed data sheets showing physical dimensions, performance data and listings/approvals.
2. Submit data sheets for products furnished under this Section, whether or not they are referenced in Contract Documents.
3. Where data sheets show multiple product items, highlight data pertinent to products being furnished.
4. Facsimile copies of manufacturer's data sheets are not acceptable.

C. Project Information:
1. Supplier qualifications certificates and documentation.
2. Contractor qualifications certificates and documentation.
3. Manufacturer's installation instructions.

D. Contract Closeout Information:
1. Demonstration and training completion statement from Owner.
2. Project Record Documents:
   a. Using shop drawings, show wiring and layout drawings to record actual construction.
3. Completed certification forms in accordance with NFPA 72.
4. Completed copy of manufacturer's standard field test report. Record all tests and system calibration using the Manufacturer's standard commissioning form.
5. Inspection certificates from authorities having jurisdiction.
6. Operation and Maintenance Data:
   a. Requirements and recommendations related to maintenance.
   b. Manufacturer's user training manuals.
   c. See Section 01 77 00.

1.7 WARRANTY

A. Warrant system against system hardware and electrical defects including programming software defects for one (1) year from Substantial Completion.

B. Beginning at Substantial Completion, provide one (1) year maintenance service by skilled, competent personnel. Include semi-annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning and adjusting as required to maintain specified or normal operation. Use only parts and supplies as used in the manufacture and installation of the original equipment.

C. UL Certificate of Installation shall be issued by the equipment supplier after the system acceptance testing, as required by the Projects City or State.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Alarm and Detection Systems:
   1. Base:
      a. SimplexGrinnell.

B. Fire Alarm Graphic Annunciator Panel:
   1. Base:
      a. SimplexGrinnell.

C. Post Indicator Valve Supervisory Switch:
   1. Base:
      a. Potter.

D. Other manufacturers desiring approval comply with Section 01630.

2.2 MATERIALS AND EQUIPMENT

A. Control Equipment
   1. Individual addressable detection device alarm threshold shall be adjustable from the control panel. The detection system shall remain 100 percent operational and capable of responding to an alarm condition while in the routine maintenance mode. Addressable detection devices shall be individually identified by the system, and any quantity of addressable detection devices shall be in alarm at any time up to the total number connected to the system.
   2. Panel annunciator shall be a 2x40-character alpha-numeric display, which shall provide a University-definable message associated with each detection device or zone.
   3. Dynamic supervision of the system electronics, wiring, detection devices and software shall be provided by the control system. Failure of the system hardware or wiring shall be indicated by type and location on the alpha- numeric annunciator. Software and processor operation shall be monitored by an independent hardware watchdog, which will indicate their failure. The system will provide failsafe operation; i.e., incoming alarms shall automatically override other modes of operation, and the panel shall automatically return to normal operating mode from any operator initiated mode.
   4. Fault detection shall be provided for initiating and audible circuits. System modules shall be capable of operation in any unused panel location. Lamp test capability shall be provided to test visual panel indicators and associated software. Provisions shall be made for remote trouble and remote alarm silencing switches. The control panel shall be equipped with a silence before reset feature, designed to prevent accidental system reset during an alarm condition. The system alarm lamp shall flash upon receipt of any alarm condition. Acknowledgment of the alarm by operation of the silence switch shall silence the audible alarm and cause the alarm lamp to light steadily. Receipt of subsequent alarms shall cause the audible devices to resound and the alarm lamp to flash.
   5. System trouble lamp shall flash and an integral trouble buzzer shall sound upon the occurrence of any trouble condition. Acknowledgment of the trouble condition by operation of the silence switch shall silence the audible alarm and cause the trouble alarm to light steadily. Receipt of subsequent troubles shall cause the trouble buzzer to resound and the trouble lamp to flash.
   6. Individual input and output device addressability as well as remote sensitivity measurement shall all be performed on the same pair of wires. Wiring shall be Class "B" and no special wiring sequence shall be required on addressable device circuits. An unlimited number of writing branches shall be permitted with no loss of supervision.
   7. Service mode shall permit the arming and disarming of individual detection or output devices as well as manually operating output devices. Status of these devices shall be displayed upon command from the control panel. The panel shall automatically return to the normal mode in the event the panel remains unattended in the service mode.

8. Panel shall be capable of receiving and processing alarms even when in the service mode.
9. Control panel shall operate from a three-wire 120 VAC power supply and internal 24 V back-up battery system with a charger capacity of up to 110 amp hours. Battery(ies) shall be 12 volt sealed, lead- acid type.. Power connections, both AC and DC, shall be separately fused within the control panel. Light emitting diodes (LED's) shall be included to indicate system power (green), trouble (yellow), and alarm (red). Trouble and alarm shall also be annunciated on an alpha-numeric display which will give device number and location plus diagnosis of trouble. Momentary contact switches shall provide for Local, Next Alarm, Next Trouble, Acknowledge/Silence and Reset. An audible device shall sound within the control panel for alarm or trouble. This device shall have two distinct sounds and shall be silence able by the acknowledge/silence switch. Alarms shall override any trouble condition.
10. Control power supply shall be capable of powering up to 960 addressable early warning detectors and at least twelve audible signal circuits. System expansion modules shall interconnect through a card edge connector and shall require no inter-module wiring.
11. Control panel shall be capable of measuring and adjusting the sensitivity of detectors.
12. An alpha-numeric display shall be provided to display custom messages and give readings of the detector sensitivity, detector by detector. Each device on an addressable initiating circuit shall be checked continuously to include the following: sensitivity, response, opens, shorts, ground faults, functionality and status.
13. Control panel shall report a device's transmitting component(s) failure, open, or shorted transmission, on an addressable initiating circuit. The device shall be recognized and identified by location within the circuit to the specific device, and other devices on the circuit shall continue to function.
14. Control panel shall report, by specific device number, any device removed from an addressable initiating circuit. Other devices shall continue to function.
15. Control panel shall allow changing the status of configured circuits (arming and disarming or changing status of relays). If any change in status degrades system operation as configured, a trouble condition shall be reported and remain until system operation again meets configured status.
16. Control panel shall have the ability to perform multiple operations at the same time. These operations shall include, but not be limited to, timed functions and multiple configured sequences.
17. Control panel shall have the ability to support a printer terminal. This printer shall be used for permanent records of the system's status and detector chamber voltages, and shall also be capable of system control as configured.
18. Control panel shall allow for expansion and shall be configurable without system inter-wiring.
19. Unacknowledged alarms and troubles shall be distinctively displayed on both the visual display and the printer, and differentiated from previous alarms and troubles.
20. System shall automatically indicate the total quantity of alarms and troubles which have occurred prior to reset at the control unit.
21. Alarm or trouble indication shall not be re-settable until it has been acknowledged.
22. The network printer shall be capable of listing, upon request:
    a. Alarm with time, date and location.
    b. Trouble with time, date, and location.
    c. Status of output functions, whether "on" or "off."
    d. Sensitivity of addressable smoke detectors.
    e. Detection device number, type, and location.
    f. Status of remote relays, whether "on" or "off."
    g. Acknowledgment time and date.
    h. Signal silence time and date.
    i. Reset time and date.

23. The system shall be capable of:
    a. Differentiating among types of addressable detectors such as smoke detectors, manual stations, water-flow switches and thermal detectors.
    b. Assigning priorities to types of detectors, zones or groups of detectors.
    c. Cross-zoning.
24. Control functions shall be assigned on the basis of system initiation patterns of detection
25. Each addressable detection device shall report its condition to the system control unit when polled. Failure of the connections to the system control unit, or internal electronics of the device will result in a trouble signal which identifies the specific device zone and/or circuit involved.
26. Addressable photoelectric- type smoke detector sensitivity shall be reported at the control panel. The electronic readout of detector sensitivity shall be equivalent to sensitivity readings made with a meter for non-addressable detector, read at the control panel digital annunciator. It shall be possible to change the detector sensitivity from the control panel within maximum and minimum values as defined by the UL and CSFM listing of the detectors.
27. The system shall be capable of listing detector chamber voltage settings on the printer for permanent record.
28. Water-flow switches, tamper switches, outside stem and yoke valves, manual stations, and thermal detectors shall be equipped with an electronic address device which shall be supervised identically as addressable detectors.
29. Water-flow switch alarm operation and automatic sprinkler system supervisory switches shall be wired and annunciated in conformance with the CSFM listing, Title 24 and National Fire Alarm Code.
30. A trouble signal shall be initiated for each addressable device for which the automatic sensitivity measurement is out of the normal sensitivity range.
31. The supervised and powered parallel output circuits shall be capable of use as audible signal circuits, fire extinguishing release circuits, municipal tie, remote station connection or general alarm release service. They shall be capable of providing 2 amps at 24 VDC.
32. Control relays in the fire alarm control unit shall be included. The dry contacts shall be rated at @ amps resistive @ 32VDC. Additional internal relay modules shall be provided to provide dry contacts rated for loads up to 10 amps @ 250VAC Resistive or Inductive.
33. Remote interface relays shall be rated at up to 120 VAC, 5 amp inductive and be self-contained in a single gang enclosure or encapsulated.
34. Remote relays located on detector bases or single gang outlets throughout the building shall be controlled in the same manner as panel mounted relays.
35. The system power supply shall be provided with an integral Uninterruptible Power Source (UPS). This UPS shall provide continuous power to the system in the event of a commercial power failure. Transfer from commercial to standby power shall be instantaneous to insure proper processor operation, and shall be indicated by flashing the system power LED. Batteries shall be sized to provide 24-60 hours of standby operation followed by 5-15 minutes of alarm. Coordinate back-up requirements with the DSFM. A dual rate battery charger shall be provided which is capable of recharging the batteries to 80 percent capacity in 12 hours. Loss of commercial power shall be annunciated as a system trouble. System trouble shall be indicated for over and under voltage conditions, blown fuse or disconnected batteries. The system shall automatically restart upon the return of power. No operator intervention shall be required. Provide a dedicated electric power circuit for the fire alarm control panel.
36. The control panel enclosure shall be beige in color, suitable for surface or semi-flush mounting. A locked door shall be provided to limit access to authorized individuals.
37. Modules shall be plug-in, dynamically supervised and easily replaceable. Field wiring shall be connected to the panel with removable multi-conductor connectors to facilitate rapid removal and replacement of both the module and wiring for ease of servicing the panel.
38. Visual indicators shall be long-life LED's. Modules capable of initiating a system trouble shall display individual trouble indications on the alpha- numeric annunciator.

39. Provide for future connection to the Campus Fiber Network. Provide a network card and two fiber network modules for future connection by the Campus.

B. Initiating Circuits:
   1. Addressable/programmable initiating circuits shall be provided by an Addressable Input Module
   2. Show on plans where devices are to be provided.

C. Output Circuit:
   1. An output circuit for operation of DC audible devices shall be provided by a Programmable Signal Module

D. Relay Module:
   1. A programmable supplementary relay module shall be provided for control of door holders, damper closure and/or fan shut down.
   2. Show on plans where devices are to be provided
   3. The module shall be Underwriters' Laboratories and California State Fire Marshal listed.

E. Alarm Initiating Devices:
   1. The addressable analog ionization type combustion detector shall be a plug-in, twist lock unit which shall be capable of removal from or installation into its base with one hand.
      a. The addressable analog photoelectric smoke detector shall be listed by Underwriters' Laboratories and California State Fire Marshal.
   2. The addressable analog thermal detectors shall be programmable for rate-compensated and/or fixed temperature type and shall be listed by Underwriters' Laboratories and California State Fire Marshal. The addressable thermal detector shall be individually annunciated on the control panel, and shall contain an integral alarm lamp.
   3. The addressable programmable interface module shall provide an interface for direct shorting contact devices to the Addressable Input. This unit is used with water-flow switch, tamper switch and outside stem and yoke valves.
   4. The air duct detector shall operate on a cross-sectional air sampling principle to overcome stratification and the skin effect. The air duct detector shall consist of an addressable ionization detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system.
   5. The in-duct detectors, provide where sampling tubed designs are not appropriate. Provide where air flow coverage is from 35-600 Ft/Min.
   6. The remote test switch, on all duct type detectors when the device's alarm LED is not clearly visible from the floor or the device is mounted higher than 9' A.F.F.
   7. The Manual station, addressable single action type, red lexan with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
   8. Provide a weatherproof enclosure or box for roof mounted or outdoor mounted devices.
   9. Show on plans where devices are to be provided.

F. Audio and Visual Alarm System:
   1. Amplifier modules shall be 8 channel digital type and electrically supervised such that a loss or reduction of signal shall result in an audible and visual trouble indication. Each amplifier shall use onboard audio NAC's. Amplifiers shall provide 35, 50 or 100 watts of output. Provide 25 or 70.7 VRMS amplifiers. No adjustment or calibration controls shall be accessible. A trouble signal shall indicate which amplifier or speaker circuit is in a trouble condition. Provide sufficient amplifiers to perform functions required, plus 10 percent spare capacity.
   2. Audio equipment trouble: Yellow LED's shall light when a trouble condition exists. Appropriate LED's to indicate the nature of the trouble shall light as follows:
      a. Fire tone
      b. Pre-Amplifier
      c. Amplifier

3. The fire alarm evacuation alarm shall be a slow whoop, produced by a solid state tone generator arranged in duplicate so that failure of the primary tone generator shall result in a trouble signal and automatic switchover to the backup tone generator. Provide a 400Hz primary tone in areas designated for experimental animals.
4. Preamplifiers shall be solid state and arranged in duplicate so that failure of the primary unit results in a trouble signal and automatic switchover to the backup unit.
5. System power supplies and remote power supplies shall be provided in sufficient quantities to provide power for all audio/visual components plus any spare capacity requirements listed elsewhere in the specification.
6. Visual devices, Audio/visual devices and visual devices on alarm speakers shall operate from an addressable indicating circuit connected or controlled by the main fire alarm panel. All the visual devices shall be synchronized. The word FIRE shall appear on the lens assembly. Visual devices shall be coordinated for wall or ceiling mount. Provide sufficient visual coverage to meet the current requirements of ADA and NFPA 72.
7. Audio devices: The horns, bells and/or speakers provided shall have a minimum sound level of 75db at ten feet. The audible devices shall be silenced at the panel without resetting the visual devices. Horns shall operate on the same pair of conductors as the visual devices. Provide sufficient audio coverage to meet the requirements of ADA and NFPA 72.
8. Show on plans where devices are to be provided.
9. DACT shall be either built-in Simplex unit or Digital Security Controls, model PC4020CF. Coordinate with telecom provider to install two lines. Coordinate with University to activate phone lines.

G. Notification Appliance Circuit Extender Panel:
1. SimplexGrinnell Model #4009-9002.
2. UL 864 listed as fire alarm power supplies.
3. Configure with circuit modules, power supplies and batteries in conformance with specified design and performance requirements.

H. Addressable Spot Type Photoelectric Smoke Detector:
1. SimplexGrinnell Model #4098-9714.
2. UL 268 listed for open area smoke detection and listed as compatible with fire alarm control panel.
3. Photoelectric light-scattering smoke detection principle with adjustable sensitivity from 0.2 to 3.7 PCT per foot obscuration and drift compensation.
4. Provide units located within electrical and telephone/data rooms with remote annunciator lights mounted outside these rooms as shown.

I. Addressable Duct Mounted Photoelectric Smoke Detector:
1. SimplexGrinnell Model #4098-9755.
2. UL 268A listed for duct smoke detection and listed as compatible with fire alarm control panel.
3. Photoelectric light-scattering smoke detection principle with adjustable sensitivity from 0.2 to 3.7 PCT per foot obscuration and drift compensation.
4. Duct sidewall mounted housing for smoke detector with sampling tubes extending the width of the duct.
5. Provide units located above ceilings or more than 6 FT. above the floor with remote test switch/LED indicators, wall mounted or ceiling mounted below units, respectively.

J. Addressable Manual Fire Alarm Station:
1. SimplexGrinnell Model #4099-9003
2. UL listed.
3. Semi-flush mounted, double-action with key reset and red face.
4. Integral interface electronics for connection to addressable device SLC.

K. Audible Alarm Notification Appliances, General Application:
1. SimplexGrinnell Model #4902-9716/9721.
2. UL 1480 listed.
3. Multiple power taps with nominal UL 1 Watt sensitivity of 85 dBA @ 10 FT.
4. Recessed flush mount installation in wall (rectangular) or ceiling (round) as shown.

L. Audible Alarm Notification Appliances, Outdoor Weatherproof and High Noise Applications (mechanical and electrical rooms):
1. Atlas Sound Model #VT-15xUC
2. UL 1480 listed.
3. Die cast metal construction with watersealed compression driver.
4. 15 Watt driver with multiple power taps and nominal UL 1 Watt sensitivity of 90 dBA @ 10 FT.
5. Outdoor units shall be surface style on weatherproof box.
6. Other units shall be surface type on interior surface box.

M. Audible Alarm Notification Appliances, Indoor Weatherproof and BSL-4 Locations:
1. Atlas-Sound Model #VTF-2xUC
2. UL1480 listed.
3. Die cast metal construction with watersealed compression driver.
4. 2 Watt driver with multiple power taps and nominal UL 1 Watt sensitivity of 90 dBA @10 FT.
5. Surface type on weatherproof box.

N. Visual Alarm Notification Appliances:
1. SimplexGrinnell Model #4906-9101
2. UL 1971 listed.
3. Adjustable output intensity set to meet or exceed the UL 1971 ratings noted on contract drawings.
4. Strobe lights shall be synchronized with each other where more than one unit can possibly be in the same field of view.

O. Combination Audible/Visual Notification Appliances:
1. Where shown together on contract plans by the use of a single symbol for both appliances, audible and visual alarm notification appliances shall be permitted to share a common enclosure provided that each appliance meets its specified requirements.

P. Addressable Initiating Device Circuit Interface Module:
1. SimplexGrinnell Model #4090-9106
2. UL 864 listed as a control unit accessory.
3. Circuit interface between an addressable device SLC and open contact devices on an IDC.

Q. Addressable Control Circuit Relay Interface Module:
1. SimplexGrinnell Model #2190-9163/4.
2. UL 864 listed as a control unit accessory.
3. Circuit interface between an addressable device SLC and control circuits of building equipment.
4. SPDT contacts rated 2 A. @ 24 VDC and .5 A. @120 VAC.

R. Rate Compensated Heat Detector:
1. Pyrochem Model #4724
2. UL listed for open area heat detection
3. Rate compensated design with spring loaded contacts in sealed tubular steel shell.
4. 140 deg. F fixed temperature setting.

S. Addressable Analog 4-20 mA. Interface Module:
1. SimplexGrinnell Model #4190-9050.
2. UL 864 listed as a control unit accessory.

3. Circuit interface between an addressable device SLC and a supervised 4-20 mA. analog loop.

T. Computer Graphic Display:
1. SimplexGrinnell 4190 Series Information Management System
2. UL 864 listed for Fire Alarm
3. 18 IN diagonal touchscreen LCD display.
4. Desktop IBM compatible PC with keyboard and mouse.
5. Network interfaces
6. Site specific programming
7. Uninterruptible power supply.

U. Printer:
1. SimplexGrinnell Model #4190-9013
2. UL 864 listed for supplementary fire alarm system operation.
3. 80 column 24 pin dot matrix.

V. High Intensity Exterior Strobe Light:
1. Acceptable to Fire Department.
2. 150,000 candlepower
3. Red lens
4. Weatherproof.

W. Addressable Notification Appliance Circuit Module:
1. SimplexGrinnell Model #2190-9159.
2. UL 864 listed as a control unit accessory.
3. Circuit interface between an addressable device SLC and polarized auxiliary relays on a Style Z reverse polarity NAC.

X. Auxiliary Control Relay:
1. SimplexGrinnell Model #2088-9010/20
2. UL 864 listed as a control unit accessory.
3. Single or quad relay with DPDT contacts rated 7A. at 24Vdc.
4. Diode polarized for reverse-polarity circuit supervision.
5. Track mounted with cover.

Y. Fire Alarm Graphic Annunciator Panel:
1. H.R. Kirkland.
2. The annunciator shall be UL listed fire alarm system equipment. The annunciator shall be semi-recess mounted where indicated.
3. The annunciator enclosure shall be constructed of cold rolled steel with welded and ground seams and finished with an exterior powder paint. The door shall be constructed of brushed stainless steel with a concealed stainless steel hinge. The door will have a gasketed minimum 3/16 IN polycarbonate viewing pane. A minimum of (5) stainless steel screws shall fasten the door against the box gasket. Tamperproof head screws shall be used.
4. The display shall be silkscreened on an anodized aluminum face with UV protection paints. Alarm LEDs shall have a brightness minimum of 600mcd. and be visible in full sunlight.
5. Lamp test switch shall be provided to test annunciator lamps.
6. An indicating light labeled "Power On" shall be provided to indicate power is being supplied to the annunciator.
7. The display shall consist of reversed printed polycarbonate lexan laminated to aluminum, with a full color image of each floor of the building.
8. The display shall indicate a plan of the building showing locations of fire command room, grade level building entrances and exits, stairs and elevators.
9. The display shall include discreet LED's in a list indicating the type of alarm including:
   a. Sprinkler Waterflow
   b. Manual Fire Evacuation
   c. Automatic Fire Evacuation

d. Supervisory
e. Trouble

10. The display shall include discreet LED's in a list indicating the floor of alarm including:
    a. First Floor
    b. Second Floor
    c. Third Floor
    d. Fourth Floor
    e. Penthouse
11. The display shall include zone annunciation which shall be backlighted areas utilizing super bright white LED lamps. Zones shall be in accordance with the sprinkler zones of the building. See sprinkler drawings for boundary lines. The illuminated and non-illuminated areas shall have the same appearance when in a normal condition. The lamp wiring shall be neatly harnessed to designated terminal blocks located in the annunciator backbox.
12. Three indicators shall light for each alarm including one for the type of alarm, one for the floor or level in alarm and one for the zone in alarm.
13. The annunciator dimensions shall be as required to produce easily legible graphics.

Z. Explosion Proof Manual Pull Station:
1. CPG Signals model MPEX or approved equal.
2. UL listed for Class 1 Div 2 area.

AA. Post Indicator Valve Supervisory Switch:
1. Potter PTS-C or approved equal
2. UL and FM Approved
3. Plug type supervisory switch
4. IP67, NEMA 5 and NEMA 6P rated enclosure
5. Operating temperature: -40 DEGF to 140 DEGF
6. SPDT Plug Contacts: 100mA at 28 VDC

BB. Conductors:
1. Fire alarm conductors shall be solid conductors. Provide 14 AWG minimum for horn and bell or smoke detector power circuits. Provide 18 AWG minimum for alarm initiating circuits and remote annunciator panel circuits. Provide twisted and twisted shielded cable as recommended by the manufacturer.
2. Fire Alarm Conductor minimum requirements
    a. Control and Communication Cable 18GA Twisted Shielded Pair (TSP);
    b. Addressable initiating devices 18GA TSP;
    c. Addressable Audio/Visual devices and speaker circuits 14GA Twisted Pair w/o shield.
    d. 4Indicating devices 14GA THHN;
    e. Conductors located in wet locations shall be THWN or equal;
    f. All cable and wire shall be jacketed to meet the requirements of their installed environment.
    g. Conductors insulation/jackets shall be colored orange and/or grey;

2.3 ACCESSORIES

A. Draftstop Material:
1. One part silicone sealant.

B. Spare Parts:
1. FAS equipment installed on the project, packaged with protective covering for storage and identified with labels clearly describing contents.
2. Supply two of each of the following:
    a. Addressable Spot Type Photoelectric Smoke Detector.
    b. Rate Compensated Heat Detector.
    c. Manual Fire Alarm Pull Station.
    d. Addressable Duct Mounted Photoelectric Smoke Detector.
    e. Audible Alarm Notification Appliance, General Application.

f. Audible Alarm Notification Appliances, Outdoor Weatherproof.
g. Audible Alarm Notification Appliances, Indoor Weatherproof.
h. Visual Alarm Notification Appliances.
i. Combination Audible/Visual Notification Appliances.
j. Addressable Initiating Device Circuit Interface Module.
k. Addressable Control Circuit Relay Interface Module.
l. Addressable Notification Appliance Circuit Module.
m. Auxiliary Control Relay.

C. Ancillary products:
1. Cabinets for system documentation in FCS.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate the work of this Section with the work of other trades and contractors.

B. Where the scope of work requires that products or materials furnished in accordance with this Section are to be installed by others, provide technical support during the installation to assure proper installation in accordance with this Section.

C. Coordinate the location of ceiling mounted equipment with reflected ceiling plans.

3.2 INSTALLATION

A. Install fire alarm system equipment in accordance with referenced codes.

B. The fire alarm system device locations on floor plans are intended to generally indicate areas where such devices are to be located. Installer shall, with aid of supplier's technical representative, be responsible for determining final location of these devices in accordance with referenced codes.

C. Riser diagrams are schematic and do not show every conduit, wire box, fitting, or other accessories. Provide such materials as necessary for a complete and functioning installation. Install in accordance with referenced codes and these specifications. Use weatherproof equipment where installed in areas exposed to weather.

D. Fire alarm wiring shall be installed in conformance with NEC Article 760. Observe the following restrictions on wiring methods permitted by the NEC.
1. Fire alarm and associated building system control wiring shall be installed in conduit throughout. Fire alarm conduit and boxes shall be painted red.
2. Fire alarm circuits required for the transmission of audible and visual alarms to any alarm notification zone shall be installed in circuit integrity cable, type CI, when running through any part of the building other than the notification zone served by those circuits.

E. Generally, conductors shall be continuous without splices from terminals on one piece of fire alarm equipment to terminals on the next. Where it is advantageous to join lengths of conductors together, the intermediate connections shall be made at labeled terminal strips in approved boxes. Splices of any type shall not be permitted except to connect to pieces of equipment that were manufactured with pigtail type connections.

F. Identify cables and conductors at each connection point with tags similar to Brady B-500+/600. Individual conductors which are part of a cable assembly may be identified by color code. Terminal strips within terminal cabinets shall be labeled to match the cables.

G. Label branch circuit breakers which feed fire alarm system equipment "Fire Alarm System", and install locking devices which prevent breakers from being inadvertently turned off but which do not interfere with automatic breaker operation.

H. Install draftstop material at penetrations in partitions not required to be firestopped.

3.3 SUPPLIER'S FIELD SERVICES:

A. Provide services of a technician, trained by manufacturer, to oversee installation, assist in locating detectors, supervise final connections, energize control equipment, make adjustments, and perform manufacturer's recommended field testing and acceptance testing.

B. Provide field services as required until work is approved by Owner and authorities having jurisdiction.

C. Test each component of Fire Alarm System, in accordance with manufacturer's recommendations, in presence of A/E and O/R.

3.4 FIELD TESTING AND INSPECTIONS

A. When the fire alarm system is being made ready for operation, the University's Representative shall be notified. Fire alarm system instruction manuals shall be submitted at least one month in advance of initiation of the system. A walk-thru of the system shall be scheduled with the SFM or DCFM and Facilities Services Administration to acquaint parties with the installation and operation of the system.

B. At least one week before turnover of the building, a fire alarm test will be scheduled with the SFM or DCFM and Facilities Services Administration or any persons designated by the SFM or DCFM, such as the State Fire Marshal, for a complete functional test of the system.

C. After the system has been tested and accepted and placed in operation, the University will assume responsibility of the system as far as future testing and responding to alarms is concerned. First year warranty problems shall remain the responsibility of the contractor.

D. Provide personnel and equipment to perform informal and formal acceptance testing and test reporting. The Owner's Representative will act in an observation role only with reference to formal system testing.

E. All formal and informal testing performed on the System shall be documented by the Contractor in hard copy format. A log of all test results shall be furnished in written form including a listing of each device and/or zone tested and a listing of the associated manufacture's point/zone number for the device and/or zone tested. The documentation shall also include a column or area for each device outlining the test comments for that device and the date when the device was tested. The actual test format to be used shall be submitted to the Owner thirty (30) days before testing is scheduled to begin. The format shall outline the proposed testing documentation to be utilized for the project. No formal testing shall be permitted until the itemized testing documentation format is submitted.

F. The system shall be one hundred percent (100 PCT) informally tested and all system malfunctions corrected before the Owner is advised that any formal acceptance testing is ready to begin. Each detector unit circuit shall be tested for trouble by inducing a trouble condition into the system. Test wiring runs for continuity, short circuits, and grounds before system is energized. Test and record resistance, current, and voltage readings. On any circuit where malfunctions occur, the defective device within the malfunctioning circuit shall be repaired and retested.

G. A preliminary test report listing each device tested shall be given to the Owner before formal acceptance testing is scheduled. The report shall outline the results of the preliminary testing, and any problems encountered and/or repaired.

H. Final acceptance of the system will not be considered by the Owner until all punch list items have been corrected. Beneficial use of the system will not be considered as full or partial acceptance.

I. Formal acceptance testing shall be performed under the supervision of a factory-trained field technician in the presence of the Owner's Representatives and AHJ. As-Built Drawings and previous test results shall be available at the time of formal acceptance testing. Tests shall be

performed on each circuit and device of the system one hundred percent (100 PCT) test. A comprehensive field test report shall be given to the Owner upon completion of the test.

J. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received.

K. Prepare test and inspection reports. Upon completion of a successful test, the Contractor shall so certify the system in writing to Owner's Representative. Submit copy of test results in duplicate, after signed off by the AHJ, to the Architect / Engineer and the Owner's Representative.

END OF SECTION

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